Vol. 27 July, 1933 No. 1

QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association

INTERNATIONAL

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Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

Acme Photo.

The Ellsworth Conflagration, May 7, 1933. The fire started in an old wooden building in the left foreground, was quickly spread through the mercantile section by flying brands alighting on wooden shingle roofs, and extended to buildings beyond the upper right corner of the picture. **(See report on page 44.)**

The Quarterly

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New England Conflagrations. The conflagrations in Ellsworth and Auburn, Maine, described in detail in this issue of the QUARTERLY, furnish further proof of the menace of the wooden shingle, adding another chapter to the record of desolation chargeable to the use of flammable roof coverings. Many New England communities took to heart the lesson of the Salem and Chelsea conflagrations and shortly after these fires enacted ordinances prohibiting the wooden shingle roof. Such ordinances cannot remove existing wooden shingle roofs which were in place prior to the adoption of the ordinance without exceeding constitutional limits. It is only after a period of years when the old shingle roofs are replaced, one by one, with fire-retardant roof coverings that the ordinance can have full effect. An illuminating illustration of this was found in the fire in Lowell, Massachusetts, which occurred on June 25, about a month after the Maine conflagrations. In 1918 Lowell put into effect an ordinance prohibiting the further use of wooden shingles on new roofs. The majority of the shingle roofs existing at that time have now been replaced, but there still remain a few which, owing to their age, are now in a particularly dangerous condition.

The Lowell fire of June 25, starting in a vacant factory in the midst of a closely built frame tenement district, quickly reached conflagration proportions and sparks were carried over a wide area beyond the main body of the fire. Almost without exception the buildings in the path of the flying embers that had fire-retardant roofs escaped without damage, but there were some twenty-five buildings within a half mile radius which had wooden shingle roofs that were ignited. Thanks to the vigilance of citizens and the assistance of fire apparatus hastily summoned from surrounding cities and towns, these twenty-five roof fires were all extinguished promptly, though in several instances not until after the building had been very seriously damaged. The fire department facilities, however, were seriously taxed, and had it not been for the large percentage of fire-retardant roofs in the district the conflagration might have destroyed almost the entire city instead of an area of two or three blocks.

Shingle roof conflagrations are by no means confined to New England. They may occur, as fire history amply demonstrates, in any city where wooden shingles are used for roof covering. The situation is slowly being corrected through the adoption of appropriate roofing legislation, but the inertia of city governments is such that intensive effort for some years to come may be necessary before our cities are relieved of this wholly unnecessary menace.

* * * * * *

1933 Fire Losses. The records of fire losses carefully compiled by the National Board of Fire Underwriters and recorded on page 19 of this issue show a continued downward trend which should be a source of distinct gratification to all fire prevention and fire protection authorities. It may be too soon, however, to draw any conclusions as to the fundamental trend, for there are so many complex and divergent factors involved, particularly the factor of the fluctuating value of the dollar, that it is probably unwise to draw any final conclusions from the present figures.

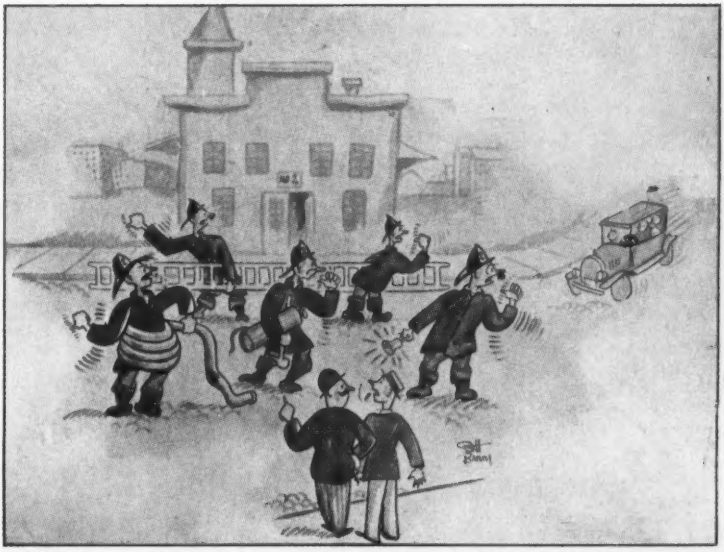
Uncertainty as to the significance of the national figures applies even more forcefully to the reports for the individual cities, where, in addition to the national factors, there may be various local influences which affect the figures. Per capita fire loss statistics have sometimes been challenged as an inaccurate method of measuring fire experience, owing to the different physical conditions in different cities. To this there is added the uncertain factor of population estimates and the still greater uncertainty in estimating the exact amount of the individual fire losses. These points should be borne in mind when referring to the tables, but it should nevertheless be remembered that despite the limitations of the per capita fire loss figure it is the only available index of the relative fire experience of different cities and that there can be no doubt that where a city shows a high per capita fire loss for a period of years there is very definite need for some corrective action.

* * * * * *

The Pyroxylin Hazard. The catastrophe in Arlington, N. J., in which ten people were killed and approximately one hundred injured again brings forcefully to our attention the well-known hazard of nitrocellulose material. This hazard has long been recognized by fire protection authorities. The N.F.P.A. has had for years regulations for safeguarding this hazard, developed and revised periodically by our Committee on Hazardous Chemicals and Explosives with the coöperation of the industry. Fires such as that reported in Arlington occur only through the most glaring neglect of well-recognized measures for the safeguarding of this hazard. In the present instance the criminal aspect of the neglect from the viewpoint of the law, is indicated by the indictment of the owner for manslaughter. This fire, however, should not be construed as an indictment of the majority of the manufacturers

and dealers in this product, who recognize the hazard and through compliance with the necessary precautions have maintained what should be considered an excellent record in view of the inherent hazard of the material.

There are now being developed non-flammable substitutes for pyroxylin materials. Eventually we may perhaps hope for the elimination of this hazard by the substitution of safer materials, but it may be years before this development is completed, and in the meantime scrupulous attention to the recognized fire safety measures is essential in the handling of the nitrocellulose product.



"You see, the City failed to balance its budget—That's our Fire Department going to a fire!"

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Meetings of Board of Directors.

Milwaukee, May 29, 1933.

Members Present.

Albert T. Bell, Chairman
Sumner Rhoades, President
H. L. Miner, Vice-President
George W. Elliott, Vice-President
F. T. Moses, Past President
Franklin H. Wentworth, Managing Director

Eugene Arms
W. E. Mallalieu
S. D. McComb
C. W. Mowry
D. J. Price
Benjamin Richards
A. R. Small
R. E. Vernor

Past President Dana Pierce was present as a guest.

The annual report of the Chairman was read and approved.

The annual report of the Treasurer was approved.

The Central Station Fire Protection Association was elected an organization member.

It was voted to hold the next meeting of the Board Monday, June 26, in Boston.

Boston, June 26, 1933.

Members Present.

Albert T. Bell, Chairman
Sumner Rhoades, President
H. L. Miner, Vice-President
Geo. W. Elliott, Vice-President
F. T. Moses, Past President
Franklin H. Wentworth, Managing Director

F. R. Bradford
W. E. Mallalieu
S. D. McComb
C. W. Mowry
S. L. Nicholson
C. W. Pierce
D. J. Price
A. R. Small
R. E. Vernor

Business Transacted.

The following officers of the corporation were elected for the year 1933-1934: President, Sumner Rhoades; Vice-President, H. L. Miner; Vice-President, Geo. W. Elliott; Chairman of the Board, Albert T. Bell; Secretary-Treasurer and Managing Director, Franklin H. Wentworth.

It was voted to hold the 38th annual meeting at Atlantic City, N. J., during the week of May 14, 1934.

The President, the Managing Director and the Chairman of the Board of Directors were constituted a program committee to whom were referred various suggestions concerning the conduct of the meeting.

The budget submitted by the Treasurer was approved.

Mr. Eugene Chrystal and Mr. S. D. McComb were selected to complete the Nominating Committee, 1934.

Technical Committee Items.

(a) Manufacturing Risks and Special Hazards.

Recommendations made by the committee for amendments to regulations governing Carbon Dioxide Fire Extinguishing Systems were approved.

(b) Electrical.

It was voted, on motion of Mr. Nicholson, that the following revision of paragraph 804-a-1 of the National Electrical Code as offered at the annual meeting by L. F. Adams *be approved:*

Plug fuses may be rendered non-tamperable either by the use of an adapter in a Standard Plug Fuse cutout base or by the use of a special cutout base. Non-tamperable plug fuses of the 16-25 ampere classification shall not be usable with the special bases or adapters for non-tamperable fuses of the 0-15 ampere classification.

Two proposed items for interim revisions of the National Electrical Code presented by the Chairman of the Electrical Committee were referred to the Technical Advisory Committee with power.

It was voted to approve the National Electrical Code in the amended form presented by the Chairman of the Electrical Committee as an amended standard of the Association.

(c) Flammable Liquids.

The following recommendations of the committee for amendments to the suggested ordinance regulating the construction and operation of Tank Trucks, Tank Trailers and Tank Semi-Trailers used for the Transportation of Flammable Liquids (see advance report to annual meeting, 1933) were approved:—

Section 9. Amend to read as follows: "Each tank truck, tank trailer and tank semi-trailer shall be equipped and maintained with at least one approved hand fire extinguisher of a type suitable for extinguishing flammable liquid fires. Fire extinguishers shall be kept in good operating condition at all times, and such fire extinguishers shall be located in an accessible place on such tank truck, tank trailer, or tank semi-trailer."

Section 10a. Amend the first two items in the third column of the table to permit the use of corrugated heads so that the first item will read: "14 gauge U. S. Standard if bilged or corrugated, otherwise 12 gauge"; and the second item will read: "12 gauge U. S. Standard if bilged or corrugated, otherwise 10 gauge."

Section 13a. Strike out the last clause reading as follows: "—and such safety chains shall exceed in length any brake hose between truck and trailer."

(d) Dust Explosion Hazards.

By consent of the committee, it was voted to delete from its report to 1933 annual meeting the following paragraph from the Regulations for the Prevention of Dust Explosions in Flour and Feed Mills:

"104. Accident Prevention: All apparatus shall be provided with the various protective appliances necessary to prevent accidents or body injuries of any kind; such protection shall comply with the existing legal or other authoritative requirements."

(e) Blower and Exhaust Systems.

By consent of the committee, it was voted to delete from the Regulations on Blower Exhaust Systems (Proceedings 1932, page 292, paragraph 161) the following paragraph:—

All apparatus shall be provided with the various protective appliances necessary to prevent accident or bodily injury of any kind; such protection shall comply with the existing legal or other authoritative requirements.

Amendments to Regulations on Technical Committee Procedure.

By recommendation of the Committee on Technical Committee Procedure, it was voted to incorporate the following paragraph in the Regulations governing Technical Committee Procedure.

48. When references are made in committee reports to the standards of other organizations, these should be only with respect to specifically identified standards or preferably to the specifically applicable parts thereof. Committees should include such references only after review of such standards.

The proposal to create a Committee on Earthquake Hazards was laid upon the table.

A list of revisions of committee personnel was approved, with certain items referred to the Committee on Technical Committee Procedure with power.

The resignation of the American Institute of Architects from organization membership was laid upon the table.

A communication on the subject of Personal Liability Laws was referred to the Managing Director.

A committee consisting of the two Vice-Presidents and the Chairman of the Board of Directors was appointed to receive the representatives of the wood shingle industry.

Building Codes and Fire Prevention.

By Frank Burton,
(Member N.F.P.A.)

Among the serious misfortunes which have periodically visited mankind from time immemorial, great fires or conflagrations have always played an important part, often destroying great cities and sometimes changing the very course of history. Unlike earthquakes and cyclones, fires are man made and can be man controlled, but it is a peculiarity of the human being that he usually chooses to disregard the possibilities of fire and considers himself much too clever to let fire get the better of him. It would be a shock to the self-confidence of the average layman to discuss the possibilities of a conflagration in his own city with the chief of his fire department. He would find that the thing which seems so remote as to be almost impossible to him is a grim and terrible possibility to the chief.

From the earliest times, cities have sought through legislation to insure against fires and the spread of fires by proper construction of buildings, but in early days adequate knowledge of proper methods was lacking, fire-resistive building materials were not available, and, strange as it may seem to us, political favoritism was, if anything, a more potent influence than it is today in defeating the enforcement of legislative requirements. Babylon had a building code in 2000 B.C., Rome had extensive laws on building construction under Julius Cæsar and probably before, but the earlier records are lost. London adopted its first code in 1189 A.D., the year the city received its first royal charter.

The records of the City of London are quite complete and most instructive. Although the code was very brief it touched upon the three most important points connected with the origin and spread of fires: the proper construction of fireplaces and chimneys; the construction of masonry walls to separate one house from another; and the construction of incombustible roofs in place of the thatched roof then much used. A study of the city records shows, however, that through the neglect of officers supposed to enforce the laws and through the political influence of many of the citizens, observance of the laws became the exception rather than the rule. In spite of reasonably good regulations the city was almost completely burned some six or seven times from 1200 to 1666. The last fire, which started on September 2, 1666, and known as the great fire of London, was the most serious of all. Parliament thereafter took the matter out of the hands of the City Council and enacted an extensive and carefully prepared law, passed in 1667, which forms the basis for all modern building requirements in Great Britain and America. No

A contemporary print of the great fire in London—1666.

serious fire has swept London since that time, nor through any other city provided with adequate regulations properly enforced.

Building Codes and Fire Prevention.

Building codes as we know them in America are so bulky, so involved and so filled with apparently irrelevant details that one not familiar with them might easily wonder what relation these requirements have to the origin of fire or to the spread of fire either through a building or through a city. This mass of detail is, unfortunately, necessary to express legally a few rather simple principles. Of course a building code is concerned with a number of matters beside the origin and spread of fire, such as structural strength and safety, adequacy of exits, sanitation, etc., but for our present purpose we shall discuss only the origin and spread of fire.

A properly prepared building code, in addition to details of construction and provisions for retarding the spread of fire, includes provisions relating to the construction and installation of chimneys, smoke pipes, stoves, furnaces, fireplaces, kilns, roasters and other cooking or heating equipment and accessories which, if enforced, will prevent fires originating from the improper installation of such appliances. Many potential sources of fires are controlled by special ordinances or regulations, such as electrical appliances and wiring, governed by a separate electrical code, or the storage and sale of flammable liquids, controlled by a flammable liquids ordinance. Other sources of fires, such as the careless use of matches or use of flammable liquids for home dry cleaning, can only be controlled by intensive educational campaigns and by early training of our school children.

In preparing a building code it is assumed that a certain number of fires will originate in the contents of buildings through any one of the many potential causes. Such requirements are included in the code as will protect the lives of those within buildings against fire and insure against an undue spread of the fire, or against excessive damage to the structure in case the fire does become extensive. American building codes generally permit small, isolated structures, such as dwellings, sheds, etc., to be of wooden wall and floor construction, although the roofs should be of fire-retardant material and all walls and partitions should be fire-stopped to prevent the vertical rise of flames, which otherwise would permit the spread of a small fire throughout the entire building. Large buildings and those located in congested sections of cities are required to have masonry walls, although wood floors and roofs are usually permitted for buildings up to three or four stories in height. Higher buildings are usually required to have floors constructed of heavy timbers, which burn much less rapidly than ordinary two-inch lumber, or a ceiling of fire-resistive construction under wooden joists. When buildings exceed five or six stories in height, or are used for hazardous purposes, such as the storage of flammable liquids, or for the assembly of large numbers of persons, it is customary to require that all floors, roof and columns be of fire-resistive construction. When steel is used in such a building it is essential that a layer of concrete, brick, tile or similar material be placed around the steel to protect it from the heat, as it would otherwise be liable to fail by softening, even though it will not burn.

Spread of Fire in Buildings.

It is not difficult to build floors and columns that will withstand the greatest fire which can be produced by the burning of the contents of so-called "light occupancy" buildings, such as apartments, hotels, schools, hospitals, churches, etc., but in the case of warehouses and factories containing large stocks of combustible materials it requires all the skill and ingenuity of present-day builders to resist the fire, and it is necessary to rely in part upon fire fighting efforts to assist in checking such large fires. If a fire sweeps through a large structure and consumes the contents, ruins the decorations, doors, windows, ceilings, floor finish and mechanical equipment, there is relatively little salvage. The building code, therefore, aims to prevent such spread of fire by confining it to the point of origin. Fire-resistive floors of proper construction will prevent the spread of fire from story to story if there are no vertical openings. It is usual, therefore, to require masonry walls around all stair wells, elevator wells and similar shafts, and the doors in such walls should be fire doors with self-closing hardware. Where light wells exist, windows opening thereon should be provided with wired glass in metal sash.

Buildings of unusual size are required to be divided into relatively small areas by masonry fire walls equipped with fire doors. Buildings of unusual

Heat from this fire sweeping through the building caused the steel members to buckle, precipitating the upper floors and roof on to those below and weakening the exterior walls.

height are required to have standpipes to the upper floors to supply water for fighting fires, and buildings involving large values either in goods or human lives are often required to be provided with sprinkler systems to supply water automatically in the event of fire. By prohibiting the use of combustible materials for partitions and other parts of the construction, fires in tall buildings may be more readily controlled. Incombustible partitions, although they are by no means fire walls, will usually effectively confine a small fire to its point

of origin. A building code cannot prevent fires other than those which might arise from faulty heating apparatus. When properly enforced it can insure that fires will not spread to any great extent until there has been ample opportunity for the fire department to extinguish the fire. Good building legislation will go a long way toward enabling the fire department to fight fires successfully with relatively little risk to its men.

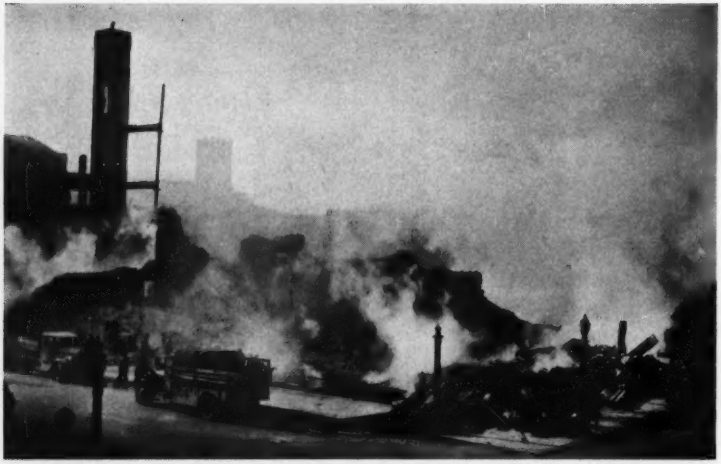
Communication of Fire from Building to Building.

The communication of fire from building to building is quite a different matter from that of its spread within a building and is of greater public concern. There is considerable misapprehension on the part of those who are not familiar with fires as to how they pass from one building to another. Many think that because one building burns the adjacent buildings are almost sure to catch fire, whereas we know that an ordinary masonry wall without openings will stop almost any building fire as long as it remains standing. Even when buildings having masonry walls with many windows, or those with frame walls burn, the fire is not communicated to the walls of other buildings a reasonable distance away. It is only when buildings with masonry walls having unguarded windows, or wooden exterior walls, are placed close together that fire is likely to travel from walls of one building to another. Even then it is rare that the exposed wall or window opening is the first to catch fire, as the projecting cornice, if of combustible material, being in a horizontal position and above the flames, is usually ignited long before the wall below is affected.

While a building code cannot properly specify distances sufficient to eliminate absolutely all possibility of spread of fire from one building to another, it can specify reasonable distances which, under ordinary conditions, will be effective. This is based on the assumption that public fire department protection is available. To express the proper requirements for a building code in simple language, we might say that frame buildings should be kept a reasonable distance apart, for example 10 feet for one-story buildings and 15 feet for two-story buildings. Higher buildings should not be of wooden wall construction, but if three-story buildings of such construction are permitted they should be at least 20 to 25 feet apart.

For dwelling houses these distances might reasonably be somewhat less where side streets 50 to 60 feet wide intervene at short intervals so that only a relatively few small buildings are mutually exposed. These distances will not insure complete safety during high winds, but will prevent the spread of fire in the great majority of cases. If cornices or eaves are to be permitted to extend into the required space the underside of such projections should be covered with sheet metal or other incombustible material.

Where it is desirable or necessary to place buildings closer together than the foregoing minimum distances, walls should be of masonry construction



The spread of fire from building to building through masonry party walls is common because openings in such walls are frequently unprotected.

and all walls facing adjoining buildings should be without openings or should be safeguarded with fire-retardant windows or with fire shutters. Fortunately we now have wired glass and metal window frames which form a substantial impediment to the spread of fire. When two buildings having windows of this construction face one another there are two lines of defense and the lateral spread of fire between them may be effectively checked.

When two buildings are built up to the same lot line the question of windows is eliminated, but other opportunities for the spread of fire are often present. Sometimes a single wall, known as a party wall, is used, which is quite proper if the wall is well constructed. The spread of fire through masonry party walls is common because openings are frequently cut in such walls. Doorways are often provided for communication which, if not guarded with well-constructed fire doors, kept in operating condition, destroy the effectiveness of the wall as a fire stop. Pipes may be carried through walls and the space around such pipes may not be properly blocked up after installation. Fire will readily travel through an opening only one or two square inches in area under favorable conditions. Ventilating ducts, chutes and other similar equipment installed between separate buildings, or parts of the same building supposedly cut off by a fire wall, are also frequent carriers of fire. When party walls are used in common by two buildings, it frequently happens that wooden joists or girders penetrate the wall from both sides in such a way that fire is transmitted from one side to the other. This can easily be avoided by proper construction.

Flying Brand Hazard.

The fact is, however, that the majority of fires which reach conflagration proportions do not spread from wall to wall, but rather from the interior of one building to the roofs of other buildings. The hot gases produced in a fire are very light in relation to ordinary air and they rapidly ascend to the upper floor of a burning building, with the result that the fire burns through the roof. If the building is burning vigorously there will be a powerful draft rising vertically through the opening in the roof. This air current carries bits of burning wood aloft, and in the case of large buildings may lift large pieces of flaming wood to great heights. If there is any wind blowing, and there usually is at least a little wind, these burning embers will be carried some distance before they fall, many of them still burning when they land. During high winds such burning embers have been carried as far as two miles or more from the original fire.

Many burning brands will, of course, strike the earth and do no damage, but when thousands are produced a few are certain to land on the roofs of other buildings. When roofs are constructed of tile, metal, slate or asphalt well covered with gravel or other suitable materials, the burning brands will be consumed without material damage to the roof. When the roof is not of proper construction, and especially when it is constructed of wooden shingles, there is great likelihood that the roof will catch fire, and if the fire department is already occupied at another fire the second building may become badly involved and act as a point of origin for more burning brands.

Fires spreading in this way cause an annual loss in the United States of many millions of dollars. The introduction of motorized fire equipment gave promise at one time of enabling our fire department to more effectively fight such fires through greater mobility, but the congestion of automobile traffic often seriously handicaps the movement of fire apparatus in the larger cities and towns during important fires.

The persistence of conflagrations spread by flying brands on combustible roofs, continuing to the present day (there have been two so far in 1933), teaches us that no city is safe from this hazard as long as combustible roofs are permitted. All other factors of fire spread from building to building are insignificant by comparison.

Development of Modern Building Codes.

It is unfortunate that wood, which is the cheapest and most convenient of all building materials, should also be an excellent fuel. As long as wood is cheap and plentiful it will remain beyond the power of legislation to prevent its use, and as long as it is used we will have many and costly fires. But we know now that it is not necessary to stop the use of wood in order to prevent disastrous fires, except in very large or very high buildings. In all other build-

Starting at the base of a rubbish chute, this fire spread rapidly to upper floors by means of unprotected openings on each floor. When the fire burned through the roof, burning brands were carried long distances to ignite some twenty wooden shingle roofs.

ings combustible materials may safely be used if the vital points of attack are guarded, and a properly constructed city of wooden buildings may be made relatively safe from serious fires by proper and reasonable regulations.

The modern American building code so far as it relates to fire protection is an effort to utilize our present knowledge for the benefit of all, and with the least possible expense to the builder. No American city in which a good building code has been properly enforced for a period of years has suffered from a great conflagration unless accompanying an earthquake, and the excellence of any given building code and the efficiency of its enforcement may be judged by the annual per capita fire losses of the city enforcing the code.

The very nature of a building code is a prohibition of that which is harmful or inferior, but with the development of the building arts which has been very rapid in recent years, our ideas of what is unsuitable change rapidly. It is impossible in writing a code to anticipate what future inventions may be made, and consequently the provisions of an old code often prohibit new types of construction which are frequently great improvements over older types. For example, the older building codes contained very severe requirements for fire-resistive floors and roofs which, while resulting in the construction of fire-safe floors and roofs, also discouraged the use of fire-resistive construction. With more recent experience it has been found that light and less expensive types of construction can be utilized which will serve safely for

many purposes, permission to use which greatly encourages the general use of fire-resistive construction. While the law does not recognize this as a necessary part of a building code, yet good sense indicates that a building code, to be of the greatest value, should not only prohibit poor construction but should encourage good construction.

So rapid has been the development of new types of construction during the past several decades that it has been necessary to revise building codes almost constantly, and most of the more progressive cities have completely rewritten their codes at intervals of ten to twenty years. If a building code is to serve to the greatest advantage it must be living, changing, progressive, keeping abreast with invention, constantly striving to improve and seeking always to remedy the weakness which develops. A code which is allowed to become fixed and obsolete soon ceases to command the respect of builders, and the requirements are evaded wherever possible. A progressive code, on the other hand, can become a powerful factor in civic betterment.

The 1932 Fire Loss.

Fire losses for the United States for the year 1932 are estimated by the National Board of Fire Underwriters at $406,885,959. This figure, determined since the publication of the April QUARTERLY, is approximately 8 per cent less than the preliminary estimate which appeared in that issue (see QUARTERLY, April 1933, page 312). The difference between the two figures used may be largely accounted for by the fact that the final adjustment of the losses varied considerably from advance estimates. The present loss figure is based upon returns made by the insurance companies reporting to the Actuarial Bureau, adding twenty-five per cent for uninsured and unreported losses.

The 1932 fire loss is approximately $45,000,000, or 10%, below the total loss for 1931 and is the lowest recorded since 1919. Due to economic conditions, however, which have radically changed the values involved, the loss for 1932, while appreciably lower in actual dollars and cents, may at the same time represent a material increase in the destruction of capital wealth. It can be said that viewed in terms of actual value, based on the U. S. Department of Labor wholesale commodity price index of 64.9 as compared with 73.0 in 1931, losses in reality increased almost five million dollars, which, while disappointing though it may be, is a more favorable record than was experienced on the same basis in 1931. This total represents only the direct fire loss, exclusive of the attendant dislocation of business and the disruption of living, production, and commerce.

The following tables give the annual fire loss in the United States for fifty-eight years and a comparison of losses on a per capita basis for the past ten years. In addition, there have been included tables showing the per capita losses of all cities of 100,000 population or over for a five-year period, and a tabulation of all cities of 20,000 population or over where the per capita fire loss exceeded five dollars during the past year. This latter group was reduced from a total of sixty-four cities in 1930 to forty-seven in 1931, and dropped to thirty-four in 1932, which may be considered an encouraging indication of results obtainable from improved fire fighting facilities and persistent fire prevention work.

For the most part the fire loss figures for cities are fire department estimates, and as such may be somewhat lower than those reported by the insurance companies. It is also to be noted that these figures may not, in all cases, be estimated on the same basis, and that they may in some cases be inconclusive if taken for a single city for a single year. This is particularly true in the case of the smaller cities, where a single large fire may materially distort the per capita figure. Nevertheless, the per capita fire losses are considered the best available index by which to compare the fire record of cities, and a high or low per capita fire loss continuing over a period of years is considered conclusive evidence of the true conditions.

Annual Fire Losses in the United States for Fifty-eight Years.

Year	Property Loss	Year	Property Loss	Year	Property Loss
1875.....	$78,102,285	1895.....	$142,110,233	1915.....	$172,033,200
1876.....	64,630,600	1896.....	118,737,420	1916.....	258,377,952
1877.....	68,265,800	1897.....	116,354,575	1917.....	289,535,050
1878.....	64,315,900	1898.....	130,593,905	1918.....	353,878,876
1879.....	77,703,700	1899.....	153,597,830	1919.....	320,540,399
1880.....	74,643,400	1900.....	160,929,805	1920.....	447,886,677
1881.....	81,280,900	1901.....	165,817,810	1921.....	495,406,012
1882.....	84,505,024	1902.....	161,078,040	1922.....	506,541,001
1883.....	100,149,228	1903.....	145,302,155	1923.....	535,372,782
1884.....	110,008,611	1904.....	229,198,050	1924.....	549,062,124
1885.....	102,818,796	1905.....	165,221,650	1925.....	559,418,184
1886.....	104,924,750	1906.....	518,611,800	1926.....	561,980,751
1887.....	120,283,055	1907.....	215,084,709	1927.....	472,933,969
1888.....	110,885,665	1908.....	217,885,850	1928.....	464,607,102
1889.....	123,046,833	1909.....	188,705,150	1929.....	459,445,778
1890.....	108,993,792	1910.....	214,003,300	1930.....	501,980,624
1891.....	143,764,967	1911.....	217,004,575	1931.....	451,643,866
1892.....	151,516,098	1912.....	206,438,900	1932.....	406,885,959
1893.....	167,544,370	1913.....	203,763,550		
1894.....	140,006,484	1914.....	221,439,350		

NOTE:—Previous to 1916 figures obtained from the records of the New York *Journal of Commerce*, deducting the Canadian losses. Subsequent years are based on returns to Actuarial Bureau of the National Board of Fire Underwriters, adding 25% for unreported and uninsured losses. The figure for 1932 is based on estimates made by the Actuarial Bureau.

Comparative U. S. Fire Losses.

	Whole Country			Cities of 20,000 Population and Over		
	Population	Total Loss	Per Capita	Population	Total Loss	Per Capita
1923.....	110,663,502	$535,372,782*	$4.84	42,946,639	$147,102,119†	$3.42
1924.....	112,078,611	549,062,124	4.90	43,375,796	146,222,749	3.37
1925.....	115,378,094	559,418,184	4.85	45,297,469	160,011,951	3.53
1926.....	117,136,000	561,980,751	4.80	53,243,778	178,178,874	3.35
1927.....	119,320,000	472,933,969	3.96	51,291,549	144,618,641	2.82
1928.....	120,013,000	464,607,102	3.87	51,836,000	140,038,116	2.70
1929.....	120,700,000	459,445,778	3.81	53,411,000	145,059,043	2.72
1930.....	122,775,046	501,980,624	4.09	50,206,000	150,981,223	3.01
1931.....	124,070,000	451,643,866	3.64	51,084,000	125,933,681	2.47
1932.....	124,822,000	406,885,959	3.26	51,295,000	113,947,789	2.22

*Estimated from Records of the Actuarial Bureau. †Figures reported by fire departments.

Losses in Cities of 20,000 Population or Over.

The losses in cities of 20,000 population and over as reported by fire department officials show a drop of 9.5% from 1931, which compares favorably with the drop in the total national loss. These losses comprise but 28% of the total loss for the country, indicating that the high level of destruction still remains in the smaller communities and rural districts rather than in the large urban centers. On the other hand, losses in this group of cities accounted for but 26.6% of the total reduction from the 1931 national loss as against 58% last year.

Per Capita Fire Losses of Cities Over 500,000 Population.

	Population	1928	1929	1930	1931	1932	Five-year Average
New York, N. Y.*.....	7,218,000	$3.19	$3.54	$3.47	$3.24	$3.38	$3.36
Chicago, Ill.....	3,475,000	3.85	4.75	4.48	2.73	3.42	3.85
Philadelphia, Pa.....	1,951,000	2.73	2.86	2.72	2.12	2.09	2.50
Detroit, Mich.....	1,479,000	2.34	2.64	2.74	2.30	1.82	2.37
Los Angeles, Cal.....	1,238,000	2.12	2.98	1.27	1.82	1.14	1.87
Cleveland, O.....	921,000	3.22	3.42	4.26	2.61	2.26	3.15
St. Louis, Mo.....	826,000	3.34	2.41	2.58	1.77	1.67	2.35
Baltimore, Md.....	814,000	1.89	1.87	2.84	1.53	3.29	2.28
Boston, Mass.....	805,000	4.98	5.30	6.54	5.14	5.27	5.45
Pittsburgh, Pa.....	700,000	1.70	2.18	1.69	1.61	1.25	1.69
San Francisco, Cal.†.....	659,000	...	...	...	...	...	...
Milwaukee, Wis.....	602,000	2.86	2.39	2.83	1.60	1.23	2.18
Buffalo, N. Y.....	573,000	3.34	4.47	2.00	2.20**	2.17	2.84

†Does not report its losses.

*These figures are based on losses paid in New York City by the subscribers to the Actuarial Bureau of the National Board of Fire Underwriters. The fire department estimates for these years were considerably lower.

**Incomplete. Does not include Buffalo Armory fire, involving loss of at least $2,500,000.

Cities from 400,000 to 500,000 Population.

	Population	1928	1929	1930	1931	1932	Five-year Average
Washington, D. C.	493,000	$1.57	$2.37	$2.59	$ .75	$ .72	$1.60
New Orleans, La.	482,000	1.77	1.54	1.57†	1.42	1.47	1.55
Minneapolis, Minn.	481,000	3.75	2.71	3.25	3.06	2.33	3.02
Cincinnati, O.	455,000	2.60	2.04	1.74	1.89	1.37	1.93
Newark, N. J.	444,000	3.57	3.01	3.62	2.82	2.14	3.03
Kansas City, Mo.	416,000	4.59	3.84	3.69	2.71	4.05	3.78

Cities from 300,000 to 400,000 Population.

Seattle, Wash.	370,000	$ .99	$2.73	$2.14	$2.94	$2.38	$2.44
Indianapolis, Ind.	364,000	3.48	3.66	2.66	1.44	1.19	2.49
Rochester, N. Y.	334,000	1.94	1.83	1.67	1.65	1.26	1.67
Jersey City, N. J.	319,000	1.01	.54	2.26	1.14	.53	1.50
Louisville, Ky.	308,000	2.80	2.52	4.33	3.19	1.53	2.87
Portland, Ore.	305,000	2.78	2.85	2.55	3.04	2.21	2.69
Columbus, Ohio	302,000	1.65	1.22	1.22	.40	.65	1.03
Denver, Col.	300,000	1.46	2.06	1.84	1.25	2.18	1.76

Cities from 200,000 to 300,000 Population.

Houston, Tex.	293,000	$5.48	$2.69	$3.05	$3.43	$4.86	$3.90
Toledo, O.	285,000	2.56	3.61	2.98	3.70	2.06	2.98
Oakland, Cal.	285,000	1.50	1.58	2.65	2.83	1.44	2.00
St. Paul, Minn.	279,000	1.98	3.39	3.68	2.70	2.67	2.88
Dallas, Tex.	277,000	5.74	5.62	6.66	5.59	4.47	5.62
Atlanta, Ga.	270,000	3.23	2.69	6.73	2.48	1.38	3.30
Birmingham, Ala.	260,000	2.38	3.26	2.11	3.09	1.93	2.55
Memphis, Tenn.	260,000	2.52	3.08	5.54	4.03	3.19	3.67
Providence, R. I.	254,000	3.23	3.74	2.86	3.63	1.39	2.97
Akron, O.	250,000	1.24	2.26	1.64	1.18	.84	1.43
San Antonio, Tex.	239,000	1.39	.68	.94	1.05	1.44	1.10
Omaha, Neb.	225,000	2.14	5.42	2.07	2.56	2.87	3.01
Syracuse, N. Y.	210,000	1.19	1.58	2.39	2.50	2.49	2.03
Dayton, O.	201,000	2.41	1.04	1.07	1.07	1.73	1.46
Worcester, Mass.	200,000	4.47	5.38	3.69	5.14	4.62	4.65

Cities from 150,000 to 200,000 Population.

Richmond, Va.	186,000	$ .66	$2.01	$ .83	$1.24	$ .65	$1.08
Oklahoma City, Okla.	183,000	1.64	3.56	3.12	1.15	.77	2.05
Youngstown, O.	170,000	2.81	2.18	3.05	1.64	.89	2.11
Fort Worth, Tex.	170,000	3.91	9.64	5.58	6.55	3.96	5.93
Grand Rapids, Mich.	169,000	2.07	1.11	1.00	2.05	.67	1.38
Hartford, Conn.	164,000	1.71	2.35	3.12	1.87	1.99	2.21
New Haven, Conn.	163,000	5.05	3.29	2.78	2.47	1.86	3.09
San Diego, Calif.	162,000	.82	.60	1.13	.57	.96	.82
Nashville, Tenn.	160,000	8.89	8.11	5.89	4.55	4.98	6.48
Flint, Mich.	156,000	2.22	1.46	2.25	.89	1.17	1.60
Springfield, Mass.	150,000	2.41	2.17	2.15	3.20	4.14	2.81

†The New Orleans per capita loss figure for 1930 obviously does not include the two wharf fires which occurred during March, 1930, with a total loss of approximately $4,000,000.

Cities from 125,000 to 150,000 Population.

	Population	1928	1929	1930	1931	1932	Five-year Average
Bridgeport, Conn.	147,000	$ .35	$ .87	$ .74	$1.05	$1.98	$1.00
Des Moines, Iowa	145,000	3.50	5.56	5.03	1.50	1.42	3.40
Scranton, Pa.	143,000	3.37	3.66	2.71	2.10	2.84	2.93
Long Beach, Cal.	143,000	1.83	.72	1.19	1.11	.43	1.06
Tulsa, Okla.	142,000	1.96	.92	1.24	.87	.84	1.17
Salt Lake City, Utah	140,000	3.16	1.64	2.90	3.07	1.52	2.46
Paterson, N. J.	138,000	5.46	4.83	8.99	3.50	2.41	5.04
Yonkers, N. Y.	137,000	1.73	2.26	1.78	2.18	1.68	1.93
Jacksonville, Fla.	135,000	2.82	1.57	3.23	8.64	4.21	4.09
Norfolk, Va.	130,000	2.50	3.17	3.11	9.09	3.12	4.20
Albany, N. Y.	128,000	3.76	3.20	2.56	4.24	1.73	3.10

Cities from 100,000 to 125,000 Population.

Trenton, N. J.	123,000	$3.92	$2.36	$1.77	$2.70	$1.12	$2.37
Kansas City, Kans.	123,000	1.52	1.47	1.00	.86	2.69	1.51
Chattanooga, Tenn.	120,000	2.53	2.21	8.57	2.91	1.27	3.50
Camden, N. J.	119,000	...	...	...	...	1.86	1.86
Elizabeth, N. J.	117,000	1.84	3.73	2.79	1.83	2.22	2.48
Erie, Pa.	116,000	.58	.70	1.08	1.78	1.86	1.20
Spokane, Wash.	116,000	2.43	6.71	2.32	2.55	1.74	3.15
Fall River, Mass.	115,000	23.70	1.37	1.60	1.69	2.36	6.14
Fort Wayne, Ind.	115,000	.92	2.31	2.16	1.56	1.02	1.59
Cambridge, Mass.	114,000	4.34	3.61	7.57	4.14	3.57	4.65
New Bedford, Mass.	111,000	2.32	1.16	1.77	1.50	.87	1.32
Wichita, Kans.	111,000	4.31	2.55	.68	.76	1.13	1.89
Reading, Pa.	110,000	8.43	4.65	2.58	3.67	.76	4.02
Miami, Fla.	110,000	3.46	1.21	.94	1.20	1.28	1.62
Tacoma, Wash.	108,000	6.13	2.19	6.09	2.93	2.51	3.97
Peoria, Ill.	108,000	3.18	3.58	2.50	2.34	3.29	2.98
Wilmington, Del.	107,000	.77	1.59	.89	2.35	2.01	1.52
Knoxville, Tenn.	106,000	1.83	1.34	3.57	1.29	1.18	1.84
Canton, O.	105,000	.91	1.96	2.59	1.12	.97	1.51
South Bend, Ind.	105,000	1.59	2.95	1.81	.91	1.20	1.69
Gary, Ind.	105,000	1.30	2.22	3.66	2.64	3.54	2.67
Lynn, Mass.	105,000	4.93	3.94	3.89	4.52	4.71	4.20
Tampa, Fla.	105,000	4.18	2.75	1.51	2.32	1.94	2.54
Somerville, Mass.	104,000	2.51	2.25	3.86	2.81	2.54	2.79
Evansville, Ind.	104,000	4.49	1.57	5.68	1.76	1.97	3.19
Utica, N. Y.	104,000	3.02	4.16	4.86	6.59	4.09	4.54
El Paso, Tex.	103,000	1.39	3.49	1.18	3.76	1.02	2.17
Duluth, Minn.	101,000	3.76	3.78	4.61	3.66	3.48	3.86
Lowell, Mass.	100,000	2.28	1.99	2.80	2.41	2.46	2.39
Waterbury, Conn.	100,000	2.95	2.59	1.78	2.15	2.33	2.36

Cities in Which Loss Exceeded $5.00 Per Capita in 1932.

****Peabody, Mass.	$14.81	**Monroe, La.	$6.86
**Bloomington, Ill.	11.75	**Wausau, Wis.	6.51
**Gardner, Mass.	10.75	*Clifton, N. J.	6.04
*Vicksburg, Miss.	9.76	**Montgomery, Ala.	6.02
***Chelsea, Mass.	9.50	**Macon, Ga.	5.85
**Middletown, N. Y.	9.29	*Watertown, N. Y.	5.77
****Passaic, N. J.	8.74	*Champaign, Ill.	5.68
**Salem, Ore.	8.21	***Leominster, Mass.	5.68
*Paducah, Ky.	7.88	***Revere, Mass.	5.58
**Newcastle, Pa.	7.60	*Reno, Nev.	5.58
**Leavenworth, Kan.	7.45	****Waco, Tex.	5.41
*New London, Conn.	7.36	*San Angelo, Tex.	5.34
*Amsterdam, N. Y.	7.31	*Allentown, Pa.	5.33
*Butte, Mont.	7.28	*Waltham, Mass.	5.28
*****Atlantic City, N. J.	7.23	**High Point, N. C.	5.28
*Washington, Pa.	7.15	****Boston, Mass.	5.27
**Jackson, Tenn.	7.00	*Shreveport, La.	5.24

Note—Asterisks indicate the number of years in which the city has been in this class during the five-year period ending December 31, 1932.

Losses Lower for First Part of 1933.

The fire losses for the United States for the first five months of 1933 were $159,694,978, which is $51,636,308, or nearly 25%, less than for the same period last year, according to estimates prepared by the National Board of Fire Underwriters. The reduction is remarkable in view of the fact that in May two conflagrations in Maine and a large pier fire at Oakland, Calif., were each responsible for losses in excess of $1,000,000.

	1929	1930	1931	1932	1933
January	$44,713,825	$42,344,035	$44,090,449	$39,224,783	$35,547,565
February	41,520,290	43,206,940	41,776,051	39,824,622	36,661,481
March	41,277,814	42,964,392	44,074,362	49,189,124	35,321,248
April	36,845,795	43,550,996	41,423,764	43,822,233	27,825,970
May	32,129,408	38,415,142	37,835,273	39,270,524	24,338,714
Total—5 months	$196,487,132	$210,481,505	$209,199,869	$211,331,286	$159,694,978

Canadian Fire Losses, 1932.

Canadian fire losses for the year 1932 amounted to $42,193,815 sustained in 47,853 fires, according to statistics contained in the annual report of J. Grove Smith, Dominion Fire Commissioner. These figures show a substantial reduction over the year 1931, both in the number of fires reported and in the aggregate loss. There were 1431 less fires and the value of property destroyed was less by $4,923,519.

While unsettled economic conditions combined with extremely low commodity price levels were unquestionably contributing factors in the 1932 loss, insured property values depreciated almost nine hundred million dollars during the period. In view of this fact it is evident that it is erroneous to assume that the apparent reduction of loss in dollars indicates a decrease in the actual destruction of property by fire. If the difference in the computed loss be balanced against the difference in insured values it will be found that the property destroyed by fire in 1932 was approximately equal to that destroyed during the previous year.

Of greater significance is the statement that while insured property losses evidenced a decrease of almost one million dollars in 1932, uninsured losses were less by more than four million dollars. Eighty-four per cent of the total loss was covered by insurance, whereas the proportion in 1931 was only seventy-six per cent. This increase may be explained by the fact that fire insurance is written for an extended period, while commodity values are subject to the constant fluctuations of supply and demand. Such a conclusion is substantiated by the Fire Marshal of Ontario, who states in referring to the experience in his province:

"In 1932, 88 per cent of the total loss was recovered by fire insurance, whereas in 1930 and 1931 it was only 80 per cent. Fire insurance being placed in advance has naturally been found to cover a larger percentage of the loss than would have occurred in more normal times."

Whether the decline in uninsured losses was due also to lower values combined with greater carefulness or merely to good fortune is not apparent from the record.

The Port Alfred pulpwood fire was the only loss in excess of $1,000,000 in 1932. There were twenty-three fires in which the individual loss exceeded $100,000 as compared with twenty-nine in 1931 and forty-one in 1930. Among the larger losses were the following, involving individual losses in excess of $250,000:

Port Alfred, P. Q.	Pulpwood pile	$2,105,000
Niagara Falls, Ont.	Clifton Hotel	644,980
Montreal, P. Q.	Canadian Vickers dock	385,000
London, Ont.	Dry goods store	371,410
Spragge, Ont.	Midland lumber yard	343,960
North Vancouver, B. C.	Sawmill	298,800
Goward, Ont.	Timagami lumber yard	280,110

The loss of life by fire during the year was 285 as compared with 251 in 1931. Of these, 131 were young children, 59 being burned in their homes during the absence of parents or other responsible persons.

A Decade of Fire Losses in Canada.

Year	Property Loss	Per Capita	Year	Property Loss	Per Capita
1923	$48,282,000	$5.36	1928	$36,402,018	$3.79
1924	45,906,500	4.99	1929	47,499,746	4.85
1925	40,729,724	4.35	1930	46,109,875	4.70
1926	38,295,096	4.15	1931	47,117,334	4.54
1927	32,254,084	3.29	1932	42,193,815	4.06

Losses by Provinces.

	Population	Loss, 1931	Per Capita Loss, 1931	Loss, 1932	Per Capita Loss, 1932
Alberta	731,605	$2,982,579	$4.07	$2,376,658	$3.24
British Columbia	694,263	3,162,394	4.55	3,299,005	4.75
Manitoba	700,139	2,517,056	3.59	1,585,906	2.26
New Brunswick	408,219	4,222,349	10.34	1,507,805	3.69
Nova Scotia	512,846	1,735,317	3.38	1,687,459	3.29
Ontario	3,431,683	15,959,308	4.65	15,466,070	4.56
Prince Edward Island	88,038	821,290	9.32	615,047	6.98
Quebec	2,874,255	12,085,135	4.20	13,911,715	4.84
Saskatchewan	921,785	3,564,485	3.87	1,673,741	1.82
Not reported	.....	67,421	...	70,409	...
Total	10,374,196	$47,117,334	$4.54	$42,193,815	$4.06

Municipal Group Classification, 1931-1932.

	1931		1932	
	Total Loss	Per Capita	Total Loss	Per Capita
Cities over 10,000 population	$17,243,580	$4.00	$13,784,209	$3.06
Towns 5,000 to 10,000 population	2,301,813	3.98	2,988,593	5.43
Towns 1,000 to 5,000 population	3,094,417	4.07	5,651,044	6.92
Villages under 1,000 population	8,246,519	5.16	7,028,765	4.39
Rural districts	17,231,005	5.63	12,741,204	3.42
Total	$47,117,334	$4.54	$42,193,815	$4.06

Occupancy Group Classification, 1932.

Group	No. of Fires	Property Loss	Average Loss per Fire
Manufacturing plants	765	$7,990,388	$10,445
Mercantile establishments	4,967	11,033,834	2,222
Residential property	35,624	13,625,641	382
Farm property (other than dwellings)	3,018	4,339,713	1,438
Institutional buildings*	472	1,479,996	3,136
Miscellaneous property	3,007	3,724,243	1,239
Total	47,853	$42,193,815	$882

*Institutional buildings include churches, colleges, schools, hospitals, convents and philanthropic institutions.

Origin of Fires in Canada, 1932.

Causes Reported	Number of Fires	Property Loss
Smokers' carelessness	10,928	$1,419,992
Stoves, furnaces and pipes	6,862	3,410,076
Electrical defects and appliances	3,272	1,652,254
Sparks on roofs	2,374	1,038,284
Defective chimneys and flues	2,282	1,403,694
Carelessness with matches	1,947	806,432
Exposure	1,151	1,985,218
Portable lamps, lanterns and open lights	1,083	241,656
Lightning	1,043	749,421
Hot ashes and coals	966	974,885
Volatile liquids	878	1,030,819
Spontaneous combustion	632	963,157
Open fires	507	267,565
Hot grease, oil and wax (ignition of)	464	107,511
Supposed incendiary	459	980,767
Miscellaneous special hazards	269	1,004,275
Fireworks	137	48,742
Miscellaneous known causes	2,599	4,427,472
Unknown causes	10,945	19,691,595
Total	47,853	$42,193,815

Fatalities by Fire, 1925-1932.

Year	Men	Women	Children	Total
1925	84	92	171	347
1926	79	86	123	288
1927	86	107	272	465
1928	51	84	179	314
1929	47	65	121	233
1930	53	91	167	326
1931	47	78	126	251
1932	61	93	131	285
Total	518	686	1,290	2,494

Fires Classified by Extent of Loss, 1932.

Losses	Number of Fires	Property Loss
Exceeding $100,000	22	$6,875,129
$50,000 to $100,000	41	2,672,594
$25,000 to $50,000	122	3,863,428
$10,000 to $25,000	267	3,427,549
$5,000 to $10,000	986	5,504,277
$1,000 to $5,000	10,015	18,066,318
Below $1,000	36,463	1,784,520
Total	47,853	$42,193,815

Ten-Year Occupancy Loss Record, 1923-1932.

Class of Property	Aggregate Loss	Per Cent of Total Loss
Dwellings (Protected Municipalities)	$49,876,043	22.0
Dwellings (Unprotected Districts)	38,163,297	
Farm Property	46,775,903	11.6
Mercantile Properties	114,308,481	28.4
Manufacturing Risks	74,816,290	18.2
Churches, Schools and Institutions	27,316,677	6.8
Miscellaneous Property	44,981,065	11.3
Sprinklered Property (All Classes)	6,652,436	1.7
Total	$402,890,192	100.0

The Oil Hazard in Modern Power Houses.

By George S. Lawler,
(Member N.F.P.A.)

Until within the last few years the fire hazard of oil used for turbine lubricating and governor operating purposes was considered small when oil reservoirs or tanks were well constructed, oil pipes were well supported in protected locations, and oil storage was in separate buildings, or rooms of fire-resisting construction with entrances closed with fire doors and with floors drained. Under these conditions the hazards were supposed to be only those of possible poor housekeeping.

Except in relatively few cases the steam pressure and degree of superheating were such that steam temperature at the throttle valves did not exceed about 600 or 650° F. If the oil happened to come in contact with hot steam pipes or chests at these temperatures, fire was not likely unless it got into the pipe coverings, in which case spontaneous heating might cause a blaze after an hour or two.

Higher Steam Pressures and Temperatures.

Within recent years, however, steam pressures have increased so that it is not now unusual to have pressures of 650 lbs., or even 1450 lbs., and two or three hundred degrees superheat. Consequently, steam temperatures, in many cases, are as high as 700, 850 or even 900 degrees Fahrenheit. When lubricating or governor oil comes in contact with metal parts heated to these temperatures the oil is bound to ignite and the extent of fire then depends upon the amount of oil involved and the means available for extinguishing it.

Steam turbines and their generators must have reliable lubrication, and, therefore, a considerable quantity of oil is needed. The usual arrangement is to have an oil reservoir, either in the base of the unit or as a separate tank in the basement, under or near the governor end of the turbine. This reservoir or tank has a capacity depending upon the size of the turbo-generator unit and may contain as much as 6500 gallons of oil in the case of the largest units. In addition a continuous central oil filtration process may be used so that even larger quantities of oil are sometimes available at any particular unit. The seemingly large quantities of oil in the tanks are needed so that if leakage occurs there will be sufficient oil to lubricate bearings until the turbines can be shut down and thus prevent possible large damage.

This article was presented as a paper entitled "The Fire Hazard of Steam Turbine Lubrication and Governor Oils" at the 37th Annual Meeting of the National Fire Protection Association, Milwaukee, May 29-June 1, 1933. (Proceedings, page 197.) The author is Chief Electrical Engineer, Inspection Department, Associated Factory Mutual Fire Insurance Companies.

The steam is admitted to a turbine through one or more governing valves which are opened and closed by oil-operated pistons in cylinders mounted above the steam valves. The valves may be directly at or on the turbine, or mounted separately a few feet distant in the case of some of the largest machines. The oil to the operating cylinders is under the control of the turbine governor. The bonnets of the steam valves are sometimes uncovered and at a temperature little below that of the steam.

Oil is normally pumped from each reservoir or tank by a pump directly to the steam valve operating cylinders and through a reducing valve and piping to the turbine and generator bearings, and thence back to the reservoir. This pump is usually driven directly from the turbine shaft, but sometimes may be driven separately by a small steam turbine. For large turbines there may be two such pumps.

In addition there is always one and sometimes two independent steam-driven auxiliary or emergency pumps located near oil tanks which automatically start and function in the event of low oil pressure, such as would occur if the regular pumps failed or there was excessive leakage of oil.

The pressure of oil as delivered by the pumps ranges from 60 lbs. to over 100 lbs. Oil at this pressure is used in the turbine steam valve operating cylinders, while the reducing valves allow pressures ranging from ten to thirty or more pounds at bearings.

The Fire Record.

The higher steam temperatures, which are now the practice, have resulted in a serious fire hazard. The records of six fires with a total loss of over a million dollars are sufficiently complete to permit drawing conclusions.

All six power houses, five belonging to utility companies, and one to a private industrial plant, were of non-combustible construction, in accordance with present practice, and had modern equipment. The walls were brick, except that in two instances temporary all-steel ends had been provided where building extensions were planned. Roofs were either of concrete or gypsum on exposed steel beams and trusses, but one power house had a false wood roof below the non-combustible roof and another had the monitor over the turbine room enclosed in a wood frame hood to prevent condensation. Floors were of reinforced concrete or concrete on exposed steel beams.

The turbine oiling and governor systems were in accordance with the usual practice. The steam temperatures were all 700° F. or above, except possibly in one instance, but in this case the hot pipes were not the initial cause of the fire. At all power houses there is no question but that the operators were particularly skilled in their duties and fought the fires as well as the fire extinguishing equipment at hand permitted. In general there was a marked similarity in the causes of the fires, course of events, difficulties encountered in extinguishing the fires and the damage done.

Before and after. Oil was the only fuel for this fire. Loss to machine $360,000, to building $60,000.

The fires will not be described in detail, as this would require too much space; only the salient features having a bearing on the needed changes will be brought out.

Four of the fires were caused by turbine oil under pressure being ejected on exposed high temperature steam pipes or chest covers, due to leaks in piping or gasket being blown out. One fire was due to a large lubricating oil pipe being broken by flying parts from a disrupted ring at one end of the generator rotor and the oil was ignited either by coming in contact with hot steam pipe or valve, or it may have been ignited by the flash or short circuit which occurred in the generator. In the sixth case an external fire spread to and ignited leaking oil and finally involved the main oil supply.

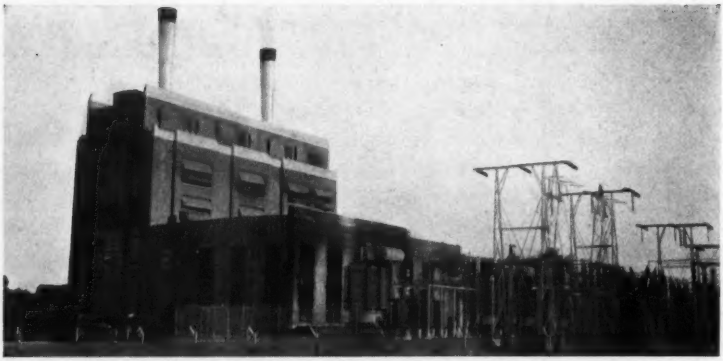
The fires enveloped the governor ends of the turbines very quickly, so quickly that in two instances the operators were unable to reach the valves to shut the turbines down. In another the operator fortunately was able to shut down the machine by means of remote control, while in still another the process was slower, as a valve in the boiler room had to be operated.

The pumps continued to force oil on to the fires until the reservoirs or tanks were practically empty. The auxiliary pumps started automatically when oil pressures were reduced and continued to operate even after the units were shut down. The auxiliary pumps, always being located near the governor ends of the turbines and in the basements, were the first of the equipment to be surrounded by fire and the control valves located close to them could not be reached even if desired. Control valves at reservoirs or tanks were also inaccessible for the same reason.

Except at the fire in the industrial plant power house, the burning oil was not only on the main floors but flowed to the basements. Consequently the fires had to be fought in both places. In all instances oil was ejected in considerable quantities so that the fires burned with great intensity and naturally with dense smoke. Except at the industrial plant, the fires extended to the roofs, although they were forty or fifty feet above the floors. One fire even passed through the skylights and rose well above the roof.

At one of the fires a good supply of carbon tetrachloride type fire extinguishers was at hand, also four soda-acid type extinguishers and two lines of $\frac{3}{4}$-in. garden hose. These, however, were ineffective and the fire burned itself out after practically all oil in the tank was consumed. Several mild explosions occurred during the fire, which lasted about one hour and forty-five minutes.

The high pressure turbine of one unit was badly damaged, cables and conduit under the floor were destroyed, several roof trusses were warped and a portion of the roof destroyed. The temporary end steel wall was badly injured and many windows were broken. The glazed brick trim was cracked and the entire turbine building suffered from smoke. A 60-ton crane, which



A modern electric generating station, with no combustible material in building or contents—except oil, which leaked on to a high pressure steam pipe, with $200,000 fire damage as the result.

happened to have been left over the turbine where fire occurred, was also damaged. The damage in the basement was not large. The loss was about $200,000.

At another of the fires only a few chemical extinguishers were in the power house, which was located two and a half miles from the city mains.

The chemical extinguishers were of no avail, and telephone request for aid was made of the public fire department about twenty minutes after the start of the fire. A pumper was sent to the power house but broke down on the way, and firemen continued on foot. They telephoned for a chemical engine and one stationed about four and one-half miles from the power house was sent. The apparatus arrived about one hour after the fire started, and a continuous stream of foam was discharged on the fire through a $2\frac{1}{2}$-in. line for twenty minutes without any apparent effect. A pumper was then called for and immediately sent. After some hesitation a large hose stream was directed on the fire and extinguished it within a few seconds. The water was then shut off but had to be used again several times, as oil became re-ignited. The fire lasted two hours and twenty minutes. After the fire the oil reservoir was found practically empty.

Fire was confined to the generator room. All window glass necessitated replacement and wired glass in the skylight was cracked. A roof truss was considerably distorted and several of the bracing members required replacement. The wall at one end of a truss was forced out two inches at the top and the wall was cracked. Several steel members above the oil tank and around the governor equipment, and the floor plates they supported, were destroyed. Oily soot was thickly deposited over the entire interior surface of the generator room. Governor mechanism at the oil tank and oil piping was damaged. Con-

sidering the length of the fire, it is remarkable that more serious damage did not result. The loss was approximately $75,000.

At another of the fires the protection was exceptionally good. It consisted of two large hose lines from connections in turbine buildings, two or three foam engines, and a number of one-gallon and one-quart carbon tetrachloride type fire extinguishers. The chemical extinguishers, which were used first, were of aid in somewhat keeping down the intensity of the fire, but fire was extinguished by the large hose streams, which cooled the oil and flushed it from the basement floor through the drain. The public department was called and brought chemical extinguishers which were used by the power house operators. The fire lasted about one-half hour.

Several steel trusses and some cross braces were damaged and the concrete roof over the turbine sagged about five inches. Some of the temporary corrugated iron and supporting steel of the temporary end of the building was warped. Fire damaged the governor end of the turbine and burned covering on the pipes, etc., in basement. A near-by power house service board suffered considerable injury. The interior of the generator building was blackened by smoke. A crane which had been left over the turbine was also damaged. The damage in the basement was not large. The loss by fire is estimated to have been about $50,000 or $60,000. Additional loss was caused by mechanical breakage that preceded the fire.

The fourth fire was in the private industrial plant. Protection consisted of a few carbon tetrachloride type fire extinguishers and several lines of large hose from the industrial plant hydrants. Five large hose streams were used at once on the fire in the basement and main floor by the mill fire brigade and public department without any attempt to use small extinguishers, as it was realized that the fire had gone beyond the stage when they had any chance of being effective. The fire was extinguished in about twenty minutes.

Damage by fire was mostly to turbine, pipes, valves, oil pumps, wiring, and miscellaneous equipment in the basement at governor end of turbine. The concrete floor at the turbine was cracked, but no other damage of consequence was done to the building except by smoke. The bearings of the turbine and generator were scored and the shaft was sprung, but this was due to lack of oil in the lubricating system before the machine could be stopped. In this case the loss by fire was only about $4500, due to the quick use of a large amount of water.

In the case of the fifth fire, protection was afforded by 54 one-quart and six one-gallon size carbon tetrachloride type fire extinguishers, also eleven $2\frac{1}{2}$-gallon soda-acid type extinguishers. From 800 to 1000 gallons of oil were consumed before the fire was extinguished, due principally to its having burned itself out. All extinguishers were used and some refilled during the fire. No water was used.

The turbine and generator suffered considerable injury, mostly due to the mechanical breakage preceding the fire. A non-combustible monitor on the turbine building, having sides of wired glass in steel frame, was badly damaged. Most of this was probably due to the fact that the monitor was enclosed by a wood frame structure which was destroyed. A 15-in. I-beam running longitudinally through the center of the monitor was buckled and the roof trusses immediately above the damaged turbine and generator were more or less warped. The interior walls of the turbine room were injured by fire, and there was some smoke damage. It was estimated that the damage done only by the fire was approximately $60,000, and that due to mechanical failure was approximately $360,000.

The sixth fire was not in this country and the information available is not complete. This was the power house that had the false wood roof below the concrete roof of the turbine building. The fire did not start by ignition of oil, but was due to burning insulation on some small wires igniting oil which had leaked into a can. The main oil supply, however, was later involved. The burning oil ignited the false wood roof and fire spread its entire length.

The information at hand does not indicate whether there was any fire protective equipment in the power house, but the public fire department arrived promptly and evidently hose streams were thrown on the fire, but they could not prevent the roof from falling. It is reported that the loss was over $1,000,000.

From the experience of these six fires the fact is evident and must be faced that lubricating and governor oil is a severe fire hazard in power houses, especially in those employing high steam pressures and superheating so that steam temperatures are above 700° F. The greatest care may be exercised that all pipes and metal parts at steam temperatures are covered as well as possible, and that baffles or shields are used over hot pipes or parts which may be uncovered, but there is always the possibility and even probability that some high temperature parts will be exposed, possibly just after repairs have been made. As long as flammable oils are used the hazard will remain, even though the flash and fire points of the oils may be made considerably higher than at present customary.

Non-Flammable Oils.

The only real remedy or method of eliminating the hazard is by the use of non-flammable lubricating and governor oils.

Synthetic lubricating oils, which are non-flammable, are now being developed and may be a future possibility. Experiments with them are being conducted in a small way, and it is understood that a turbine driving a 3500-kva. generator is now being lubricated with such oil. It is obvious that experiments and tests must be prolonged before those operating large turbines will feel safe in using these non-flammable oils. In the meantime there is

encouraging information to the effect that the synthetic oils may be considerably improved and finally have the desired quantities and reliability.

An emulsion of about one-quarter oil and three-quarters water has appeared on the market. Such a lubricating medium, if successful, may not entirely eliminate the oil hazard, but it will, at least, very much reduce it, for less oil will be present and it will be so mixed with the water that it will not burn readily. It is also understood that oils having higher flash and fire points are available, and these will tend to reduce the hazard.

The oil in the turbine governor systems is more hazardous than that in the lubricating systems, as it is under higher pressure and, therefore, leaks are more likely to occur; also the hot piping and steam valve operating cylinders are so located that oil can readily come in contact with them. As the oil in these systems is not needed for lubricating purposes there seems no important reason why it should not be divorced from the turbine lubricating systems, except for the complications and added expense which will result. If the lubrication and governor systems are made independent, synthetic oils, or even some other medium, could be used in the governor systems and the present flammable oils used only in the less hazardous lubricating systems pending improvements and confidence in the lubricating qualities of the synthetic oils.

Even this change would go a long way towards reducing the fire hazard and would be well worth while in preventing severe losses and interruptions of service in large valuable properties upon which the public depend in so many ways at the present time.

Location of Oil Tanks.

For such time as oil must be retained in connection with reliable turbine operation it is very desirable that oil tanks be so located that they will be reasonably remote, or protected from oil fires which may occur at the turbines. Preferably the tanks should be in separate, well cut-off rooms of fire-resisting construction. This, undoubtedly, will be a troublesome problem, as it will add to the cost of the power houses. More space will be needed and additional piping required.

When the tanks are safely located, the emergency pumps and controlling valves for lubricating and governor systems can also be located distant from possible fires at turbines. Such accessibility at times of fire is important and will make it possible for operators to at least shut the valves of governor systems and prevent oil in them being ejected on to a fire in any large quantity. This will tend greatly to prevent large fires with their consequent extensive damage.

It is obvious that the quantity of oil in the lubricating and governor oil systems should be the minimum needed under the conditions. If the oil control valves for tanks and pumps are always accessible in event of fire the

Wreckage of a Brussels power station, where oil and a wooden roof contributed to a fire loss reported to be over $1,000,000.

amount of oil would not be so much of a factor, although it is still desirable to have as little of it as possible. The covers should be kept on oil tanks to keep fire out.

As to whether the valves in lubricating systems should be closed during a fire is a matter for display of good judgment. Turbines continue to rotate for a long time after the steam is shut off, and to prevent damage to bearings, which is likely to be followed by damage to shafts, turbine blades and other parts, it is essential that lubrication be not interrupted until the rotors come almost to rest. The damage to the turbines due to lack of lubrication may be greater than that caused by fire.

If the turbine unit is brought to rest very quickly, due to mechanical breakage, as occurred at two of the fires, there is no question but that the quick closing of valves in the lubricating system is highly desirable.

Oil piping should be extra heavy and carefully and substantially supported in as protected locations as possible. All joints should be welded as far as practicable to prevent leakages, although some flexibility is desirable so that vibration will not be likely to cause breakage.

Leakage of Oil.

It goes without saying that conditions as regards leakage of oil and cleanliness around pumps, piping and tanks should be excellent. Even a small fire from any cause which might otherwise be of little importance may ignite an oil film on equipment, or pools of oil on floors or at pumps, and result in a fire which may spread, involve more oil, and result in serious damage.

First aid equipment, of course, is necessary to handle small fires which may occur from time to time, but it is entirely inadequate to cope with a

serious fire when oil is being continuously ejected either by the pumps or by leakage from an oil tank.

Where a large quantity of oil is being forced from a leaking joint or a broken pipe, it falls in such a way that carbon tetrachloride or foam is ineffective. One of the fires mentioned can be taken as an example. Oil not only flowed and splashed over a considerable surface around the governor end of the turbine on the main floor, but passed through openings in the floor and fell to the basement, splashing and falling over various pipes, etc., in its course. The foam and carbon tetrachloride which was used from what was, beyond question, a reasonable number of extinguishers to be kept in a power house, had little effect on the fire. It could not have been otherwise under the conditions, for the fire was not of the kind where such extinguishers could have been effective. They could only have been effective in mopping up a fire when almost burned out or nearly extinguished by some other means. At another of the fires, as already mentioned, a continuous stream of foam was thrown on the fire by the public department for twenty minutes without any apparent effect, while at still another of the fires foam from several large foam extinguishers, in addition to the carbon tetrachloride used, had little or no effect. Burning oil fell on the foam as fast as it was used.

Water in Ample Quantity Needed.

The experience at all six of the fires mentioned indicates clearly that water in ample quantity is needed to extinguish fires in the high flash point oils by cooling them below their flash points. Water was, fortunately, quickly available and used at once at two of the fires. One was at the private power house, where the industrial plant employees were "water-minded" and had no hesitation in using it almost exclusively. The five large hose streams made short work of this fire. At the second fire two streams were used, but with slight hesitation, and the result was the same. At another fire the water used, after a long delay, extinguished the fire immediately after the other extinguishers had failed. At two of the remaining fires no water was available, or at least not used, and the fires lasted until they practically burned themselves out. At the sixth fire water was used, but details are lacking.

Large hose connections with $2\frac{1}{2}$-in. hose having 1-in. or $1\frac{1}{8}$-in. nozzles attached to them should be provided at locations which will always be accessible in case of fire on the main floors and basements of all turbine buildings. An alternative would be fully equipped hydrants just outside the buildings. At least two streams should be available at any point where a serious oil fire may occur. The water supply should be continuous where possible, either from city mains or pumps, or at least sufficient to last for an hour and a half or two hours. The pressure at connections with the streams in use should not be less than fifty pounds. There should be no hesitation in using the streams.

The electrical apparatus in the vicinity will not usually be of the type which will be seriously injured by water, and the operators should be able to make any electrical apparatus "dead" before the water could be used.

Automatic Sprinklers.

Automatic sprinklers, controlled by valves normally kept shut and so located that fire will not render them inaccessible, should be installed in the basements above oil tanks, pumps and piping, and where burning oil may fall through main floors above. The sprinklers should have a closer spacing than is the usual practice.

In many power houses the installation of sprinklers is essential if an oil fire is to be quickly extinguished and controlled. This is particularly the case in the large power houses where the basements are very high, apparatus is crowded and many pipes are present which would obstruct hose streams. Dense smoke and heat also are likely to interfere with the operators or firemen getting near a fire with hose lines. In such cases water from the sprinklers will reach the fire and extinguish it, or at least control it, so that the hose streams can quickly put it out. Less water will be needed to extinguish an oil fire where sprinkler protection is afforded than where it is absent, and in some instances it may even make the use of hose streams unnecessary.

It goes without saying that no combustibles should be used in the construction of power houses. Two of the fires emphasize this. If the wood false roof had not been provided in one case there is no doubt but that the damage would have been much less, and in the second case if the monitor had not been enclosed by a wood frame structure the damage to the non-combustible monitor would have been less than it was.

To provide for the ready escape of water and unburned oil the basement floors should be well drained and pitched slightly towards such drains.

Conclusions.

Summing up, the principal precautions to be taken and protection needed to eliminate, or at least control, the turbine oil hazard in power houses are as follows:

1. Use non-flammable oil in governor systems and also for lubricating purposes as soon as it is proven suitable.
2. Restrict the quantity of flammable oil to the minimum needed.
3. Locate tanks containing flammable oils where the oil will not be involved in a fire at turbines, and keep covers on.
4. Locate pumps and valves controlling oils where they will be accessible in case of fire at turbines.
5. Substantially support all oil pipes in as protected locations as practicable.
6. Prevent oil leaks, and maintain clean conditions at oil tanks, pumps, piping, etc.
7. Provide ample first aid equipment of suitable type for small fires, and large hose protection with an ample supply of water at good pressure for large oil fires in turbine buildings.

8. Provide sprinkler protection in turbine building basements, over oil tanks, pumps, piping and where ignited oil may fall from main floor.
9. Turbine building basement floors should be well drained.
10. No combustibles should be used in the construction of power house buildings.

Although the scope of this paper has been limited to the hazard of turbine lubricating and governor oils in view of the present interest in such oil fires, there are still other serious fire hazards in large power houses. These can well be the subject of another paper.

Hangar Fires, Roosevelt Field, N. Y.

The burning of eleven airplanes in a fire-resistive hangar at Roosevelt Field, Long Island, N. Y., on June 2, 1933, has again focused attention on this particular field, where four fires involving losses amounting to approximately $100,000 or over have occurred during a little more than two years. The first of these fires destroyed three hangars and damaged a fourth of the old row of wooden wartime structures which were grouped along the northern boundary of the field. The other three fires resulted in the virtual destruction of three of the seven modern steel and concrete hangars. These fires demonstrate, anew, the hazard incident to the storage of highly combustible materials in buildings of even non-combustible construction and emphasize clearly the desirability of automatic sprinkler protection. None of the hangars involved in these fires was sprinklered.

Fire of February 2, 1931.

Three hangars and three airplanes were destroyed in a fire which occurred during the night and threatened for a time to destroy the entire group of wartime wooden hangars that stood parallel to Old County Road on the north side of Roosevelt Field, L. I. The fire was discovered by a night watchman in an empty hangar formerly occupied by the Eastern Aeronautical Corp. at the east end of the row. He sounded the field fire siren which summoned fire companies from near-by towns. The fire departments responded promptly, but before they could get streams on the blaze it had spread to two more hangars, one being the building formerly occupied by Columbia Air Liners, Charles A. Levine's company.

In this latter structure were three airplanes which had recently been sold to satisfy a judgment against Levine for rent on the hangars. They consisted of two experimental amphibians and the *Uncle Sam*, a huge machine constructed of duralumin built for a trans-Atlantic flight. Within fifteen minutes after the fire had attacked the oil-soaked timbers of the old building this machine was but a mass of melted white metal.

The cause of the fire was attributed to defective wiring, although incendiarism was at first suspected. An investigation which was made satisfied

International.

Ruins of wooden hangars at Roosevelt Field, L. I., N. Y., destroyed together with contents in spectacular night fire on February 2, 1931.

field officials that the fire was not set. The loss to the hangars was estimated at $70,000, while the loss to the airplanes (the original cost of which was in excess of $200,000) was $3,000, which figure represents the actual cost to the owner in whose possession they were at the time of the fire.

Fire of April 28, 1932.

At 9:10 A.M. on April 28, 1932, a fire occurred in the main hangar portion on the first floor of Hangar "A," located at Clinton and Old County Roads in the southeast corner of Roosevelt Field. This was a two-story structure of fire-resistive construction, having walls of brick, concrete floors and a roof of corrugated iron on unprotected steel trusses. The fire started in a large twin motor amphibian plane, the property of John Hay Whitney, and was in the nature of a flash fire. The exact cause of the fire is unknown. It occurred while the mechanic in charge was making routine adjustments to the landing gear, and spread with such rapidity that only two planes in front of the open door at one end could be run out before the gasoline tanks of other planes began to explode, spreading the fire throughout the main portion of the hangar.

The mechanic was severely burned by the initial flash and another mechanic who went to his assistance was also injured. These two men were alone and unable to make use of first aid equipment in time to check the blaze. Moreover, the entire contents of the hangar portion of the building are said to have been involved and burning fiercely within a few minutes. A local alarm was sounded and an alarm was transmitted to the fire department over the telephone by an employee.

Fire departments of several surrounding towns responded promptly and are said to have done efficient work. An ample supply of water was available

International.

Fire-resistive hangar at Roosevelt Field, Long Island, showing damage caused by fire of April 28, 1932. Note roof trusses collapsed from excessive heat, resulting in severe damage to inside walls.

from the private yard mains and hydrant system provided at the field, and the fire was extinguished by the use of hose streams in a little more than an hour.

The airplanes in the hangar, one of which was valued at $50,000, were completely destroyed. The intense heat on the exposed steel roof trusses supporting the corrugated iron roof of the hangar portion caused the complete collapse of the roof and badly damaged the inside walls of the building, so that although the fire did not enter the other sections of the building the loss was estimated as nearly total. The loss was estimated to be in the vicinity of $150,000.

Fire of February 14, 1933.

This fire occurred in one of several identical unsprinklered hangars of fire-resistive construction on the north side of the field. The main hangar was 120 by 98 feet in area, one equals two stories high, with concrete floor and with a roof consisting of a steel deck on unprotected steel trusses. The roof deck was insulated, and covered with composition roofing. Brick walls with protected openings at each side of this area cut off two-story fire-resistive wings which were occupied by offices, shops, boiler rooms, dope rooms, etc. The ends of the hangar consisted of sliding steel-frame doors with windows of wired glass. A number of privately owned airplanes with highly combustible wings and fuselages were stored with wings overlapping in the main hangar.

Acme Photo.

General view of hangar fire of February 14, 1933, at Roosevelt Field, Long Island. The planes in the foreground were removed to safety during the first stages of the fire.

The fire started in a monoplane in which the owner was demonstrating a landing flare to a friend. The flare, consisting of a tube filled with several pounds of magnesium and a cartridge, ignited accidentally as he was replacing it in the holder. The fire quickly spread throughout the plane and to other planes near by, and about 25 people in the hangar rushed for the doors, dragging four planes with them. It was impossible to use hand equipment, which included a 40-gallon foam extinguisher, because of the intensity of the fire and exploding gasoline tanks. Near-by fire departments responded to an alarm, and hose streams from convenient hydrants were in use within ten minutes.

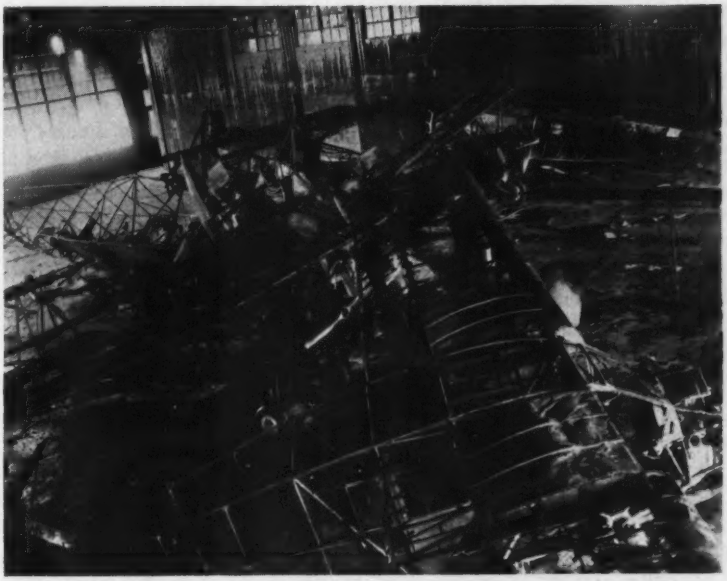
About 20 minutes after the start of the fire two roof trusses collapsed, pulling part of the wall with them. The hangar contents were almost entirely consumed and the main part of the hangar practically destroyed. Fire entered the dope room adjoining through a blocked fire door. The walls and floors of both wings were cracked. Seven airplanes were destroyed. The loss to the airplanes was estimated at $40,000 and to the hangar $52,000.

Fire of June 2, 1933.

The fourth large fire at Roosevelt Field, L. I., occurred shortly before 10:00 P.M. and, like the two preceding fires, involved a modern hangar of fire-resistive construction. The fire was discovered by a motorist passing

along Old County Road, who gave the alarm. The cause of the fire could not be determined, although an exhaustive investigation was made.

The fire spread rapidly and soon involved the entire structure. A mechanic sleeping on the second floor of the building escaped unharmed by jumping from a window. Hose streams used by firemen from near-by towns prevented the spread of the fire to other hangars. Ten airplanes were destroyed and one other was badly damaged. The hangar was severely damaged. The loss to airplanes and hangar (orginally reported in excess of $250,000) was approximately $65,000, of which $35,000 was to the hangar.



Keystone.

Interior of hangar of fire-resistive construction, at Roosevelt Field, Long Island, after it had been swept by fire on June 2, 1933. Ten planes were destroyed and one other badly damaged.

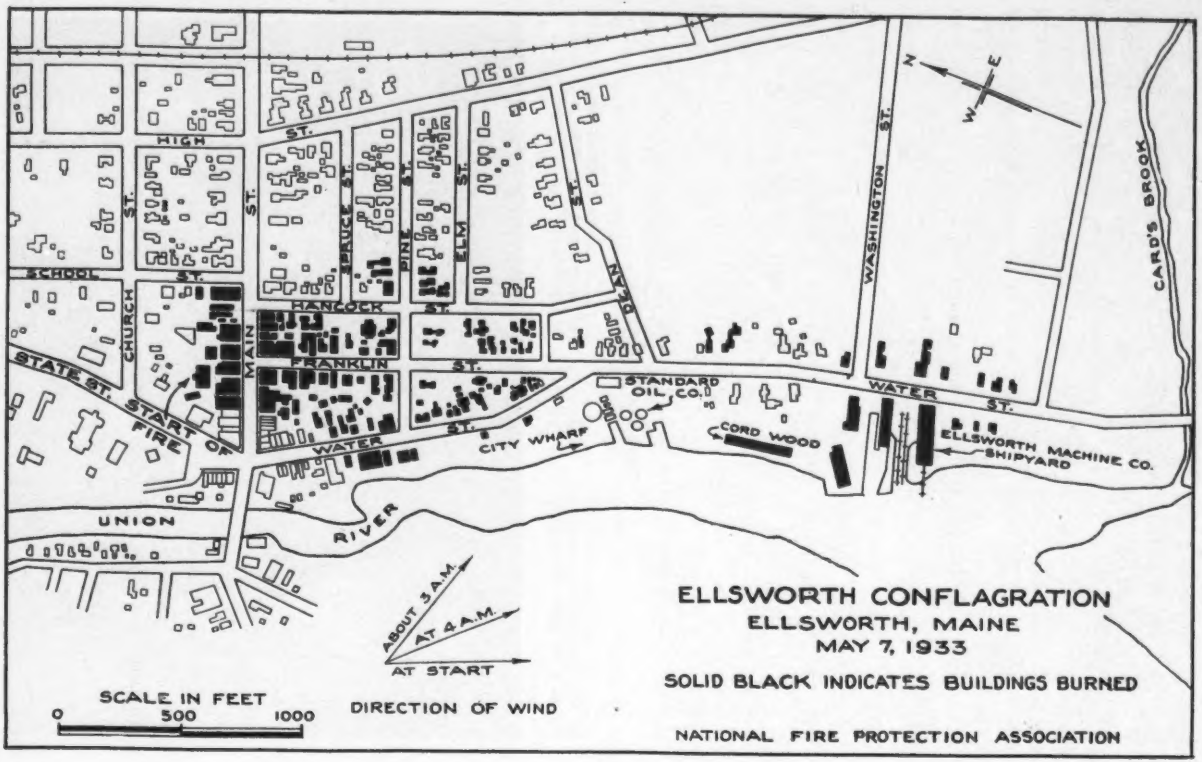
Ellsworth, Maine, Conflagration.

Under conditions similar to those that prevailed in Nashua, New Hampshire, three years ago, the city of Ellsworth, Maine, on Sunday, May 7, 1933, paid dearly for permitting the unrestricted use of wooden shingles as roof covering throughout the municipality. Thoroughly dry, and with a strong wind blowing to carry embers and to fan them into flames when they landed, wooden shingle roofs were the means of developing, within fifteen minutes of the first alarm, a fire of conflagration proportions which wiped out the major portion of the business district and approximately a third of the residential section. The fire was checked only when it reached the outskirts of the city.

Ellsworth, the county seat of Hancock County, is a city of 3500 people situated on both sides of the Union River, about 26 miles from Bangor and 20 miles from Bar Harbor. The accompanying map shows the mercantile section and a part of the residential district with houses well spaced. A large boatyard, where many motor cruisers and yachts belonging to summer residents of Bar Harbor were stored, was located on the river bank at the outer limits of the built-up section. There were no building restrictions and no structures of even slow-burning construction existed in the city. Wooden shingle roofs predominated, and of the 127 buildings totally destroyed 94 are listed as having this type of roofing.

The area of the territory burned was approximately three-quarters of a mile long and about one-third of a mile wide. The property destroyed included 50 dwellings, 45 buildings occupied for mercantile or light manufacturing purposes (including public garages), 10 buildings used for storehouses, two churches, a fire station, a city hall, and a group of buildings used as a boat shop and shipyard, and 16 buildings used for miscellaneous purposes. The property loss (exclusive of records and indirect losses) is estimated at $1,350,000, of which approximately $275,000 was on the shipyard. In addition to the buildings totally destroyed, approximately 15 were damaged to some extent. About 300 persons were rendered homeless.

Aside from the mercantile establishments, public buildings and the shipyard, the values involved were moderate. The city hall and six mercantile buildings were of brick-joisted construction. All other structures, including dwellings, were of wooden construction. The residential district consisted of one- and two-family dwellings, and of the fifty which were destroyed forty-nine had wooden shingle roofs. Both churches were of wooden frame construction with wooden shingle roofs. An unusual feature of this residential district was the small number of detached garages or other outbuildings. For the most part the dwellings in this city have barns and sheds attached which, since the advent of the automobile, have served as garages and storerooms.


HIGH ST.
SCHOOL ST.
CHURCH ST.
MAIN ST.
SPRUCE ST.
PINE ST.
ELM ST.
HANCOCK ST.
FRANKLIN ST.
STATE ST.
START OF FIRE
WATER ST.
CITY WHARF
STANDARD OIL CO.
CORD WOOD
WASHINGTON ST.
WATER ST.
ELLSWORTH MACHINE CO. SHIPYARD
CARD'S BROOK
UNION
RIVER
N
W
E
ABOUT 3 A.M.
AT 4 A.M.
AT START
DIRECTION OF WIND
SCALE IN FEET
0 500 1000
ELLSWORTH CONFLAGRATION
ELLSWORTH, MAINE
MAY 7, 1933
SOLID BLACK INDICATES BUILDINGS BURNED
NATIONAL FIRE PROTECTION ASSOCIATION

F. C. Scott.

The start of the conflagration. This old wooden building used as a storehouse had long been recognized as a fire menace. Note the furious burning of the wooden roof.

Weather Conditions.

Weather conditions on Sunday, May 7th, were favorable for a fire. The evening was cool, the temperature being about 28° to 30°, and a fresh breeze had been blowing all day from the north and northwest. At the start of the fire the wind was almost directly from the north, shifting to the west at about 3:00 A.M. Monday, and then back to the north an hour later. It was this wind that gave impetus to the original fire and carried the flaming brands across Main Street into the residential section, starting numerous fires on wooden shingle roofs.

Story of the Fire.

The fire had its origin in an old two-story frame building, 112 by 40 feet, once used as a theatre but more recently used for the storage of old lumber, waste wood and similar material. It was situated at the rear of a group of frame mercantile buildings on the north side of Main Street (see the accompanying map). This structure was in poor condition and had been considered a serious fire menace. A petition seeking its condemnation on the grounds that it was a fire hazard had been presented to the city council on the Tuesday preceding the fire and referred to the building inspector for report.

The cause of the fire was not definitely determined at the start, but a strong suspicion of incendiarism was held by police and fire department

D. M. Maher.

A night picture showing the conflagration at its height, looking eastward across Main Street towards Hancock Street. Fire fighting operations were necessarily limited to the edges of the conflagration. The central area burned rapidly.

officials. Several investigations were made, resulting on Thursday, May 11, in the arrest of one Norman Moore, a Hancock County farm hand, who had been employed in a Main Street restaurant as dish washer. He was held in the county jail after he had signed an alleged confession to the effect that he started the fire to see the fire department in action, and "because something in his head told him to."

The fire was discovered at about 9:45 P.M. by two boys, who telephoned an alarm to the fire department. The two pumpers responded promptly, each with a driver, leaving the fire station on Franklin Street immediately after sounding the fire alarm siren to notify the call firemen and summon the company from Ellsworth Falls, two and a half miles away. One call man accompanied the apparatus from the station, and the other call men, most of whom lived near by, were on the scene within a few minutes.

Two hose lines were at once laid from the nearest hydrants on Main Street and streams directed into the burning storehouse. These were immediately followed by two additional lines, making four in all from these two hydrants. On the arrival of the small pumper from Ellsworth Falls, suction was taken from the river and two lines stretched across State Street to protect exposures to the west and southwest of the burning storehouse. The 600-gallon pumper was sent to a hydrant on State Street and two streams were brought to play, from a bluff at the north, on to the roof of the burning storehouse. The 350-gallon pumper joined the pumper from Ellsworth Falls, drafting water from the river and supplying two more streams.

The fire swept through the large frame building with tremendous rapidity and the entire structure was soon ablaze, creating so much heat that the hose streams apparently had but little effect. Burning brands were carried by the wind across Main Street and within fifteen minutes the wooden shingle roof of the Franklin House, a two-story frame structure on the west side of Frank-

D. M. Maher.

Corner of Main and Hancock Streets at the height of the conflagration, showing character of construction and extreme rapidity of burning.

lin Street next to the corner of Main Street, was ignited. This roof and building were well involved before effective hose streams could be brought into play, and soon the wood cornice of the two-story wooden block across the way at the corner of Main and Franklin Streets was ablaze and the fire was eating its way into the building. This building housed the telephone exchange, which was rendered useless in about thirty minutes. From here the course of the fire is difficult to trace, but it spread rapidly through the somewhat congested district extending southward along Franklin and Water Streets before starting up the hill along Main Street. Flying brands ignited roofs far ahead of the main fire, which also spread by radiated heat and direct contact.

After the frame mercantile buildings on the north side of Main Street, approximately half of which had wooden shingle roofs, had ignited either from brands or direct contact, the fire attacked the old brick-joisted mercantile structures on the south side of Main Street. It entered these latter buildings by means of radiated heat through windows and by the ignition of awnings and window frames from burning brands. As the wind drove the heat and flames across Main Street the position of the fire department became untenable and it was necessary to abandon the hydrants first taken and leave the hose lines with water still running. This resulted in a considerable loss of water and pressure and severely handicapped fire department operations at other points.

On both sides of the lower end of Main Street blank brick walls, aided by weak hose streams, were effective in stopping the spread of fire in this direction. In the other direction it advanced toward the large brick city hall at the corner of School Street, known as Hancock Hall. An attempt was

D. M. Maher.

Looking west on Main Street about two hours after the start of the fire. The dwelling at the extreme right was dynamited just after this picture was taken in a futile attempt to save Hancock Hall, just outside the picture at the right.

made to save this building by dynamiting an intervening two-family frame dwelling, but in the excitement there was some confusion in arranging the wires and the charge failed to explode. A second attempt was successful and the house, which was on fire by this time, was reduced to a pile of blazing débris. Meanwhile the delay in setting off the charge gave the fire an opportunity to involve the heavy wooden cornice of Hancock Hall, and it is stated that the roof and attic were well afire when the adjoining dwelling was finally razed. Moreover, the force of the explosion shattered the windows in Hancock Hall, contributing to the spread of flames into the building.

The devastation of Hancock Hall was complete, the interior being entirely gutted, and only the four bare walls remained. Practically all of the city records were destroyed. It is stated that in the early stages of the fire in the building some doubt was expressed as to the security afforded by the so-called "fireproof" vault in the building and an attempt was made to move the records to a place of greater safety. One trip was made successfully, but before a second trip could be made the fire had gained such headway that salvage efforts had to be abandoned. The vault door was left open and the records remaining were destroyed.

The progress of the fire through the residential section south and west of Hancock and Main Streets is difficult to outline, for, according to eyewitnesses and fire department officials, the fire jumped from one location to another as the stronge breeze carried burning embers on to combustible wooden roofs. Practically all the dwellings involved in the fire were roofed

D. M. Maher.

The Methodist Church on Hancock Street, ignited by flying brands falling on the wooden shingle roof, was an easy prey to the flames. This picture was taken shortly after midnight.

with wooden shingles and, with a few exceptions where hose streams were immediately available and could be used to good advantage, the destruction was complete. It is stated that in the vicinity of Water and Washington Streets the shipyard and adjacent buildings were on fire some time before the main fire had reached the junction of Water and Franklin Streets.

Along the easterly side of Hancock Street a determined effort by the fire department, aided by a shift in the wind and the presence of fire-resistive roofs, was successful in holding the fire at this point. The 600-gallon pumper of the Ellsworth fire department was stationed at a hydrant on Pine Street above Hancock and its streams were helpful in checking the spread of the fire from the Baptist Church and adjacent dwellings eastward along Pine Street. The heat at the corner of Pine and Hancock Streets opposite this church was sufficient to melt the hose connections out of the barrel of the hydrant located at this point. Hose streams used on lower Hancock Street were a factor in saving several dwellings in this vicinity, the front walls of which were scorched by heat radiated from burning dwellings across the street. The wooden shingle roof of a new garage at the corner of Hancock and Elm Streets was ignited and considerably damaged before it could be extinguished. A portable forest fire pump sent from Bar Harbor, together with water pails, wet brooms and mops used by citizens were also factors in extinguishing many incipient roof fires throughout this district.

Along Franklin Street, Water Street and the lower end of Pine Street the intensity of the fire was such that but little could be done in the way of effective fire fighting. At Franklin and Water Street hose streams from

The spread of fire along Water Street near the junction of Franklin Street was retarded by these buildings. Both were in the direct path of flying embers and were saved by fire-resistive roof covering. The rear addition of the building in the center had a wooden shingle roof, but was saved by hose streams.

pumpers drafting water from the Union River at the city wharf were effective in preventing the destruction of several dwellings, the roofs of which had ignited. Another pumper stationed on Water Street between Dean and Washington Streets, where two dwellings were destroyed, was a factor in preventing the spread of the fire to other buildings in the immediate vicinity.

The plant of the Standard Oil Company on Water Street was in the direct path of the fire but escaped injury. A Bangor pumper located on the adjoining wharf used one hose stream to cool the tanks, although being in a valley, it is probable that the intensity of the heat was less and that burning embers were carried over this area.

The ignition of the shipyard seems to have resulted following the ignition of dry grass by flying embers, spreading first to some piles of cordwood and thence to near-by buildings and the shipyard. More than twenty valuable motor cruisers and yachts in winter storage were destroyed. As far as can be ascertained no hose streams were available at this point when the fire first reached here. Later two pumpers were stationed at Card's Brook and used hose streams on the burning dwellings on Water Street in the vicinity of the shipyards. Beyond this was open country.

A check up of the burned area with the latest available Sanborn maps indicates that there were 127 buildings totally destroyed and 15 damaged to some extent. A number of others suffered negligible damage to roofs or wooden gutters, or were scorched by heat from burning structures near by. Seventy-four per cent of all the buildings destroyed had wooden shingle roofs,

This fire-resistive roof on a Water Street dwelling was in the direct path of flying embers, which passed over it and ignited and destroyed the two dwellings, the ruins of which are shown in the foreground.

and of the dwellings destroyed ninety-eight per cent were so roofed. This factor was primarily responsible for the spread of the fire in the residential section.

The Amount of Loss.

The property loss is estimated at approximately $1,350,000, exclusive of records and indirect losses. The insurance loss is estimated at from $800,000 to $925,000. It is estimated that approximately $275,000 of the loss, with insurance of perhaps $175,000, was incurred in the shipyard of the Ellsworth Machine Co., where more than twenty yachts and motor boats were docked for repairs or in winter storage. Among those destroyed were two modern 75-foot yachts valued at approximately $50,000 each. There were but few partial losses, and for the most part losses were either total or almost negligible.

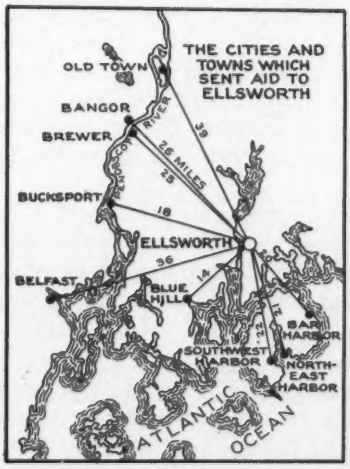
Fire Department Operations.

The Ellsworth fire department consists of two paid drivers and sixteen call firemen at the Central Station and twelve call firemen at Ellsworth Falls. They are under the command of a chief and three assistant chiefs, all of whom are call men. All fire alarms were received by local telephone and the alarm sounded by transmitter on the siren on the fire station. The apparatus at the Central Station consisted of a 350-gallon motor pumper and a 600-gallon motor pumper, the latter carrying a number of ladders in lieu of a ladder truck. The company at Ellsworth Falls was equipped with a 250-gallon pump. This force might be considered adequate for ordinary fires which could be attacked in their incipient stages, but with the conflagration well under way it became necessary to call for assistance from other cities and towns, the nearest of which was fourteen miles away.

The response to the alarm appears to have been prompt, and little delay was made in getting hose streams on to the fire in the burning storehouse. As indicated by the foregoing text the first lines were laid from hydrants, after which the 350-gallon pumper was sent to draft from the river along with the small pumper from Ellsworth Falls, while the larger pumper took water from a hydrant on State Street. As the fire progressed these companies were shifted to various points, as were the companies arriving from other communities. For the most part, companies arriving from outside took their own positions.

The first request for outside aid was made by Chief Goodwin, who called Bangor at ten o'clock, requesting aid from that city and asking that the Bangor chief transmit the call to other fire departments in the vicinity. Other calls were put through to Bluehill, Bar Harbor and other towns before the burning of the telephone exchange cut off all communication.

Apparatus began to arrive from the outside in response to the appeal as early as 10:30 P.M., and continued to arrive at short intervals until after two o'clock Monday morning. Nine cities and towns contributed a total of eleven pumpers ranging in capacity from 350 to 750 gallons per minute. Bangor sent two hose trucks along with its pumpers, and Northeast Harbor sent a ladder truck. A 600-gallon pumper from Bar Harbor broke down en route and a light truck with a forest fire pump was dispatched in its place. This truck did effective work in chasing sparks and burning embers on roofs in the residential section. The table on the next page shows the cities and towns which rendered aid, the distances traveled, time of run, and approximate time of operation.



Ellsworth and all the cities that sent apparatus except Bar Harbor have standard hose couplings. The out-of-town equipment could therefore connect with Ellsworth hydrants and piece out each others' hose lines, except that the pumper from Southwest Harbor carried suction hose which could not be connected to the pumper connection of the Ellsworth hydrants. The Bar Harbor forest fire truck used its own 1½-inch hose and water tank and the matter of different couplings was no bar to its effective operation.

Most of the pumpers responding from outlying communities took suction from the Union River. At least two of these took suction at the rear of the

This picture shows the ruins of the two-story wooden building at the corner of Main and Franklin Streets, which housed the telephone exchange. This building was involved early in the fire, preventing further use of the telephone for summoning outside aid.

Outside Help Sent to Ellsworth.

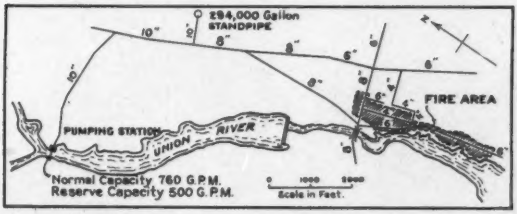
City or Town	Approximate Time of Arrival	Motor Pumpers	Men	Number of Streams Used	Miles	Approximate Time Run	Approximate Time Operation
Bangor	11:00 P.M.	2	19	4	26	50 min.	8 hours
Belfast	2:05 A.M.	1	6	2	36	55 min.	3 hours
Bluehill	10:30 P.M.	1	—	2	14	27 min.	
Bar Harbor.....	12:30 A.M.	1	5	1	20	35 min.	14 hours
Brewer	11:10 P.M.	1	3	—	25	55 min.	
Northeast Harbor...	10:28 P.M.	1	15	1	21	28 min.	10½ hours
Old Town.....	1:10 A.M.	1	14	2	39	54 min.	8 hours
Bucksport (Town)..	No report	1	No report		18	No report	
Bucksport (Mill)....	No report	1	No report		18	No report	In reserve
Southwest Harbor...	11:30 P.M.	1	6	2	22	30 min.	7 hours

Peters Block on State Street near the bridge and others at the City Wharf adjoining the Standard Oil plant on Water Street. Two pumpers took suction from Card's Brook at the extreme limit of the fire area. The tide was favorable at the start of the fire, making a draft of from nine to ten feet for pumpers stationed at the City Wharf.

While the water supply from the river was ample, the necessity of laying long lines to reach the fire and the use of small nozzle tips cut down the effectiveness of some of the streams. In spite of this, the help received by out-of-town companies was of great value and was an important factor in preventing much greater destruction.

Water Supply.

The water supply for the city is privately owned, being furnished by the Penobscot Water Company. The pumping station is located about 2½ miles from the center of the city. There are two motor driven centrifugal pumps having a combined capacity of 760 gallons per minute and a centrifugal pump of 750 gallons per minute capacity driven by either an electric motor or by a gasoline engine. When operated by the gasoline engine the pumping capacity



Factory Mutual Record.

Map showing the water supply and distribution system of Ellsworth, Maine, at the time of the conflagration of May 7, 1933.

of this latter pump was reduced to from 450 to 500 gallons per minute. This pump was held as a stand-by pump and ordinarily attached to the gasoline engine.

The pumps take water from the Union River above a dam, and pump direct into the mains through about 1¼ miles of 10-inch pipe overflowing to a standpipe, 80 ft. high, of 294,000 gallons capacity. From the junction of the 10-inch pump main and the 10-inch main from the standpipe, an 8-inch pipe extends down State Street to the center of the town. The normal static pressure at Main and State Streets with the standpipe full is in the vicinity of 100 lbs. With the exception of 8-inch mains on State and Main Streets the water pipes in the fire area were 4 inches and 6 inches in diameter. Normal consumption was about 205,000 gallons per day.

At the start of the fire the level of the water in the standpipe was down to about the 60-ft. level, reducing the quantity available to approximately 200,000 gallons. The pumps were not operating.* Shortly after the alarm was sounded the two electrically driven pumps were started and maintained 102 pounds pressure at the pump house until an hour and fifteen minutes later, when the power was cut off due to public utility men shutting off the power lines on Main Street where the fire was raging. The gasoline driven pump was then started, maintaining a pressure of 87 pounds at the pump house. At the end of an hour the power supply was restored, and with the electrically driven pumps again in operation the pressure at the pump house was maintained at 98 pounds during the duration of the fire. The pumps were operated until 10:00 A.M. on Tuesday, when the standpipe was again full.

The numerous hose lines laid from hydrants in the fire area shortly after the commencement of the fire severely taxed the water system and the level

*Note:—A measuring device with which the system was equipped was not in operating condition. It was customary for the waterworks superintendent to note the pressure gauge in his residence from time to time and when the pressure dropped to a certain point (50 lbs.) to proceed to the pumping station and start the pump. The standpipe is usually filled at night by the use of the small pump (280 g.p.m.), which is operated for about twelve hours. The fire occurred at about the time the pump would ordinarily be put into operation.

The fire was spread beyond the closely built area by brands falling on wooden shingle roofs. Roofs newly shingled ignited under the shower of sparks just as did the old tinder dry roofs. The roof of this garage at the corner of Hancock and Elm Streets ignited, but was extinguished by hose streams. Note unburned corner of roof, showing new shingles.

of the water in the standpipe was seriously reduced, although it was officially reported that it did not drop below the 25-foot level. This, however, accounts for the poor streams noticed by observers. When the fire crossed Main Street two hydrants were abandoned and left open, which further depleted the water supply, and as the gasoline driven pump was the primary water supply at that time, hose streams were very weak. Shortly before midnight a Bangor pumper attempted to connect to a hydrant near Hancock Hall at Main and School Streets, but could get no water at that point.

As the fire spread through the residential sections many service connections were broken off, which further depleted the water supply and lowered the pressure. One pumper, located on the lower end of Water Street and pumping from a hydrant, showed 15 inches of vacuum on the suction side and 65 lbs. pressure on the discharge side. This pumper was serving two lines of 700 feet each provided with $\frac{7}{8}$-inch and 1-inch tips.

Safes, Vaults and Record Losses.

As far as record protection equipment is concerned, this conflagration teaches no new lesson, and the experience of such equipment serves to bear out the lessons already learned from past fires and laboratory tests. While an examination of the ruins disclosed some softened and melted glass (glass melts or softens at from 1400° to 1700° F.), there were no evidences of exceptionally high temperatures. This is probably due to the open character of the area burned over and to the readily combustible character of the structures involved which facilitated rapid destruction. For the most part the maximum temperatures were not of long duration and it seems probable that in general the intensity of the fire, in any given building, did not exceed that of one hour

Ruins of Hancock Hall. Every trace of combustible material in the structure and contents of this building was completely destroyed, including valuable city records which for the most part cannot be replaced.

on the standard time temperature fire test curve. This curve reaches a temperature of 1700° F. at one hour, 1850° F. at two hours, 2000° F. at four hours, etc.

Thirty-two safes were involved in the fire, three of them bearing the label of Underwriters' Laboratories with a two-hour rating (B label), and the remainder being iron safes 25 to 100 years old. Of the thirty-two safes, six had been opened and the contents removed before or during the fire. The remaining twenty-six went through the fire, were removed from the ruins and opened after they had cooled. Of the twenty-six thus opened and examined eleven failed to protect their contents, six protected their contents from total loss but with some water damage and scorching, and nine came through in excellent condition with no injury to contents.

Three of the safes which came through the fire without damage were those bearing Underwriters' Laboratories labels; the others were cast iron safes of varying types and age. Those which failed to protect their contents were old iron safes. One old heavy wall type safe which failed had been through a previous fire twenty-eight years ago. Another old iron safe in the same building fell on top of a fuel oil tank and, although subjected to considerable sustained heat, protected its contents satisfactorily.

A heavy wall type safe in a dry goods store probably would have burned out except for the fact that it fell through the floor into an open sewer. This cooled the safe and no damage was done other than from water seeping into the safe. In the store of the Westcott Hardware Co. some doubt was felt as to the security afforded by an old-fashioned safe and the records were removed to a vault in a building across the street. This vault had 12-inch brick walls with a single door of sheet iron. When the building containing the vault

burned, the sheet iron door failed and the contents of the vault were destroyed. Meanwhile, when the hardware store burned down the safe fell outside the building and had the records remained in their original place they would have been safely preserved.

Mention has been made of the loss of city records through the forced abandonment of salvage efforts in Hancock Hall resulting leaving the vault door open. Most of the important city records were thus destroyed and it is estimated that the cost of replacing those which are subject to duplication will be in the vicinity of $40,000 to $50,000. Two safes were in Hancock Hall in addition to the vault. They were located about ten feet apart on the first floor. One was an old key lock safe, 60 to 70 years old, and the other was an old style heavy wall type cast iron safe at least thirty years old. The key lock safe fell on top of the débris and protected its contents, while the other, buried for some days in the ruins, was completely burned out.

Conclusions.

Combustible frame construction, wooden shingle roofs and a high wind, combined with limited water supplies and fire fighting facilities, were the factors primarily responsible for this conflagration. Wooden shingle roofs predominated and ample evidence was presented as to the behavior of these roofs under conflagration conditions. There is no question in the minds of fire department authorities that these roofs were responsible for the rapid development of the fire into conflagration proportions.

The water system was not equal to the demand placed upon it, either as to the pumping or storage capacity or as to the size of mains. It was severely overtaxed by the number of hose lines taken from it at the start of the fire, which condition was accentuated by the temporary shutting off of the power supply and the draining of the system by hydrants left open and broken service connections.

While the fire department did the best it could, sufficient equipment was not quickly available to handle the fire once it got a foothold south of Main Street. The fire department lacked training in handling large fires, and it seems probable that its efforts were concentrated too long on the original fire with insufficient attention to protection of exposures.

Response of outside companies to Ellsworth was prompt and effective, but in some instances such response left the community from which these companies came entirely without protection and remote from outside aid.

Auburn, Maine, Conflagration.

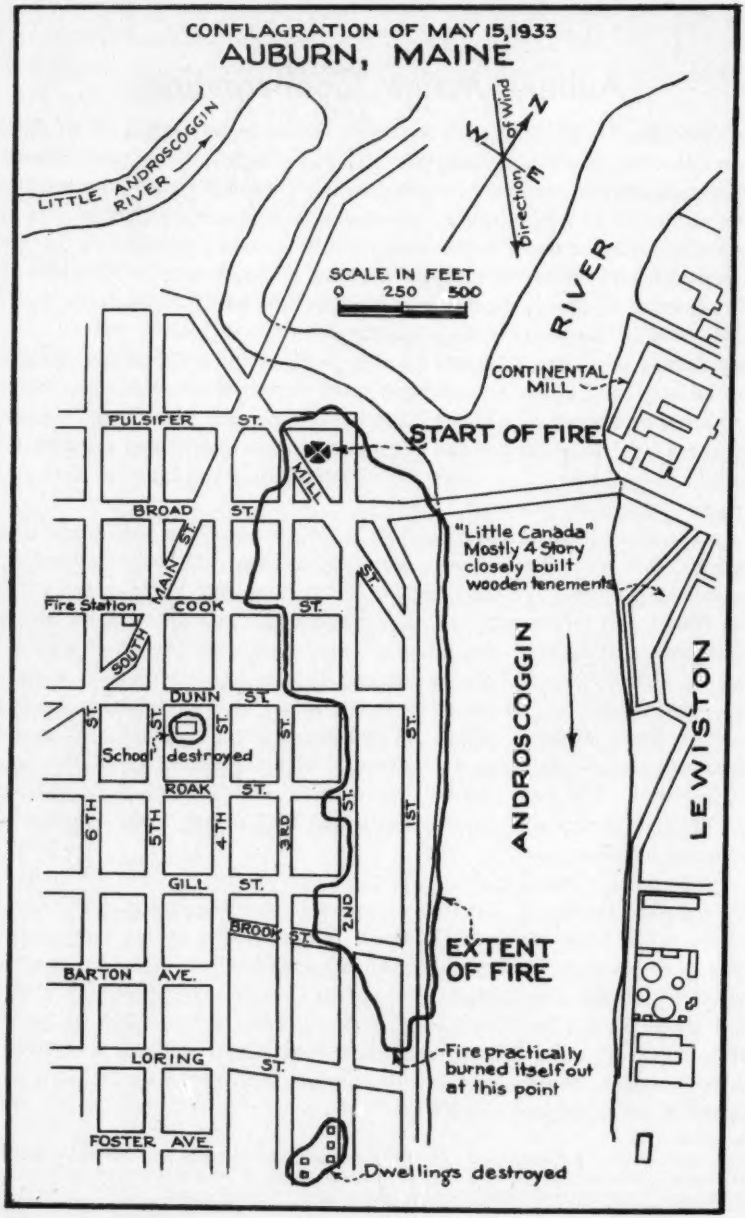
On May 15, 1933, just a week and a day after the conflagration which swept the City of Ellsworth, another Maine community, Auburn, was visited by a conflagration, resulting in the destruction of 250 buildings in the business and residential section known as New Auburn. This was a congested area of frame construction and wooden shingle roofs. Delayed response of the fire department and limited water supplies, combined with weather favorable to the spread of fire, created conditions which facilitated the rapid development of the original blaze into a fire of conflagration proportions.

Auburn is a manufacturing city of approximately 18,000 people, situated on the west bank of the Androscoggin River directly across from the City of Lewiston. It is about 33 miles from Portland on the main highway to Augusta. The area involved in the fire was a minor mercantile district and a residential section of moderate value, consisting of multi-family residences or flats and one and two-family dwellings.

The area of the territory involved in the fire was about half a mile long and 600 feet wide. The property destroyed included 125 buildings used for residential purposes,* 22 small mercantile structures, two bakeries, two packing plants, two public garages, two schoolhouses, a slaughter house, and a synagogue. There were also 94 small structures of minor importance destroyed, such as detached private garages, sheds and poultry houses. A number of other buildings, not included in the above, had some damage done to roofs by reason of flying brands. In addition, a group of farm buildings was destroyed and two dwellings were damaged by flying brands across the river in Lewiston. The total property loss is estimated at from $1,500,000 to $2,000,000. About 422 families, including 2167 people, were temporarily rendered homeless.

The burned area is in the southeastern part of the city about a mile from the principal mercantile district and separated therefrom by a small stream known as the Little Androscoggin River. It is connected with the city proper by a bridge over the Little Androscoggin River and with Lewiston by a bridge across the Androscoggin River. The district is built along the side of a hill, and grades from First Street, which follows along the river bank, to South Main Street are steep. These grades might conceivably handicap fire fighting to some extent. Streets for the most part are fifty feet in width and practically all are paved and improved.

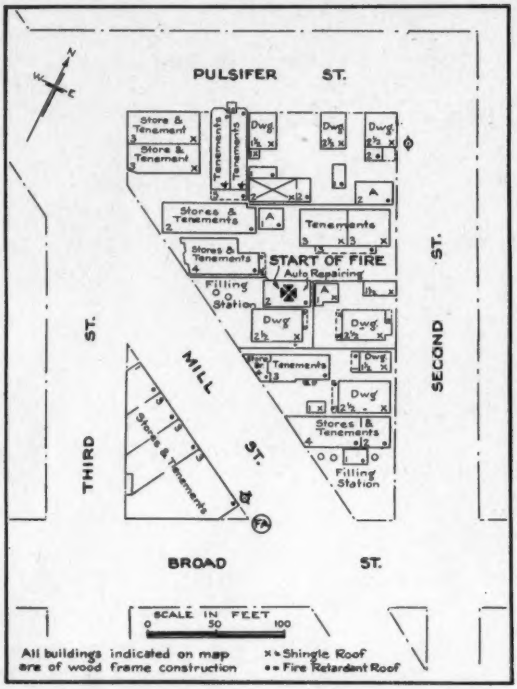
*A number of buildings used primarily for residential purposes had mercantile establishments on the ground floor and apartments above. About 40 mercantile establishments, including a small department store and a branch bank, were wiped out.


CONFLAGRATION OF MAY 15, 1933
AUBURN, MAINE
LITTLE androscoggin RIVER
Direction of Wind
SCALE IN FEET
0 250 500
RIVER
CONTINENTAL MILL
START OF FIRE
PULSIFER ST.
MILL
BROAD ST.
MAIN ST.
"Little Canada" Mostly 4 Story closely built wooden tenements
Fire Station
COOK ST.
SOUTH
DUNN ST.
School destroyed
ROAK ST.
GILL ST.
BROOK ST.
BARTON AVE.
LORING ST.
FOSTER AVE.
6TH
5TH
4TH
3RD
2ND
1ST
ANDROSCOGGIN
LEWISTON
EXTENT OF FIRE
Fire practically burned itself out at this point
Dwellings destroyed

International.

General view of the Auburn conflagration. The point of origin of the fire is in the foreground, and the smoke shows the direction in which the fire spread along the river bank. The picture also shows how the geographical conditions and wind limited the ultimate spread of the fire.

The greater part of the district consisted of buildings used for residential purposes. Of these, thirty-four were tenement houses or flats ranging in height from three to five stories and housing from three to eight families. Ninety-one were one- and two-family dwellings. All were of frame construction. Walls were mostly covered with clapboards, but a few had wooden shingles. While most of the flats and some of the dwellings had fire-retardant roofing, more than 80 per cent of the latter had wooden shingle roofs. Of the mercantile and manufacturing establishments, all but four were of frame construction. Two buildings, the P. A. Dupont and Co. bakery, a three-story frame structure on Mill Street, and the Lee W. Davis Co. slaughter house, a concrete and frame structure on First Street, were equipped with automatic



Sanborn Map.

Sketch showing block in which Auburn fire started. Note congested area of frame construction.

sprinklers. One schoolhouse was of brick construction, while the other was frame with a wooden shingle roof. The Beth Abraham Synagogue at Cook and Second Streets was a three-story brick building.

Weather Conditions.

Weather conditions on May 15th were favorable for a fire. Although rain had fallen five days before, a low humidity had prevailed for a considerable period. The day was warm and a fairly strong breeze, estimated from 35 to 38 miles per hour, was blowing from the northwest. This breeze fanned the small initial blaze into a conflagration and carried the fiying brands southward along the river, starting fires all over the area on dry wooden shingle roofs.

Events Preceding the Fire.

A factor contributing to the rapid spread of the fire during its early stages was that the fire department was already engaged in fighting two fires, alarms for which had been sent in just previous to the outbreak of the con-

J. M. Morrison.

When the fire department arrived five buildings were on fire, and within fifteen minutes the entire block appeared doomed. The picture, looking southeast at Mill and Third Streets, shows Auburn firemen getting into action and the fire spreading across Mill Street to attack the Shapiro Block (right).

flagration. At the first of these alarms a combination hose and chemical truck from the Central Fire Station was engaged in fighting a brush fire approximately three miles from headquarters. At the other, a dwelling house fire, two pumpers, a ladder truck and a combination hose and chemical truck were in service. This left the engine company ordinarily stationed at New Auburn, two blocks from the start of the conflagration, the only company available in event of another fire. This company, as is customary, had left its own quarters in New Auburn and was "covering-in" at headquarters. As a result but one engine company responded on the first alarm sounded for the conflagration, and this company was approximately a mile away at the start of the fire.

Story of the Fire.

The fire, said to have been started by a mentally deficient eleven-year-old boy who has since been committed to a state institution, had its origin in a two-story frame automobile repair shop at the rear of a gasoline filling station at 14 Mill Street. This structure was located in the center of a block of frame buildings bounded by Mill, Pulsifer, Second and Broad Streets, and was closely adjoined by a four-story frame store and tenement on one side and a 2½-story frame dwelling on the other. Both of these buildings are said to have been involved when the first fire company reached the scene.

The fire was apparently discovered by several persons simultaneously and an alarm was sent in from a fire alarm box at Broad and Mill Streets, which

J. M. Morrison.

This store building at Mill and Pulsifer Streets was separated from the start of the fire by a large wooden tenement block. It was soon in flames, however, and completely destroyed within a short time in spite of the efforts of the fire department, who were handicapped by low water pressure. Note ineffective stream operating at left of picture.

alarm was recorded at fire alarm headquarters at 2:00 P.M. The New Auburn pumper, with three full-paid and five call men, made the run from the Central Station promptly, but on their arrival firemen found that the fire had communicated to adjoining buildings and it is stated that five buildings were already on fire. In the meantime the Lewiston Fire Department, in accordance with the mutual aid agreement existing between the two departments, had responded with a pumper and a ladder truck, reaching the fire at about the same time as the New Auburn pumper. A second alarm was turned in at 2:02 P.M., and a call for additional assistance from Lewiston was transmitted at 2:04 P.M.*

Hose lines were stretched down Mill and Third Streets by the Auburn firemen, and up Mill Street from Broad Street to the south side of the fire by Lewiston firemen. These lines were put into operation almost simultaneously. The fire had gained such headway, however, that the firemen could not hold their positions and the Auburn men retreated to Mill and Pulsifer Streets,

*The fire alarm systems of Auburn and Lewiston are interconnected and a mutual aid agreement provides that in event of a second alarm or a box alarm for a second fire in Auburn, a pumper and ladder truck from Lewiston will immediately respond.

J. M. Morrison.

Thirty minutes after its start the entire block in which the fire started was in flames and the fire was attacking the large wooden block across Mill Street. Firemen were forced from their positions by the advance of the fire.

concentrating for a time on the large frame mercantile block on the corner and later protecting exposed structures on Third Street. To the south the fire spread so rapidly that the Lewiston firemen were forced to abandon the hydrant first taken at Broad and Mill Streets and leave their hose lines to burn in the street with water flowing.

From the point of origin the fire raced through the block bounded by Mill, Pulsifer and Second Streets and crossed Mill Street to attack the Shapiro Building, a three-story frame structure housing a department store and a branch of the First Auburn Trust Co. Driven by the wind, the fire continued its way southward along First and Second Streets. It did not progress steadily from building to building, but jumped here and there as sparks and embers carried by the wind landed on wooden shingle roofs. Individual fires sprang up, making it possible for the fire department to cover but a few of them, and inside of thirty minutes from the start of the fire calls for assistance were sent out to cities and towns within a radius of forty-five miles. As early as 2:14 P.M., fourteen minutes after the first alarm, an alarm was received from box 213 at First and Brook Streets, almost half a mile from the start of the fire. Two other alarms were received from this box at 2:20 P.M. and 2:24 P.M., indicating that flying brands had already started roof fires on lower First Street.

Two sprinklered buildings, one of frame and the other of concrete block and frame, severely exposed by burning frame unsprinklered buildings, soon ignited and were destroyed. The water pressure by this time was probably below an effective working pressure for sprinklers and the amount of water delivered by the sprinklers is questionable. In any event a sprinkler system

International.

The Auburn conflagration at its height. Fourth Street in the foreground. Effective work on the part of the fire department, helped by a favorable wind, prevented the spread of the fire westward beyond the limits indicated by this photograph.

J. M. Morrison.

The New Auburn fire area viewed from the north bank of the Little Androscoggin River. The fire may be seen sweeping through the congested tenement house district at First and Broad Streets.

inside a building of combustible construction could scarcely be expected to cope with a serious fire coming from outside the building, and the destruction of these buildings is clearly chargeable to their construction and lack of protection against exposure rather than to the failure of their interior sprinkler systems.

At Cook and Second Streets the Congregation Beth Abraham Synagogue ignited by radiated heat through exposed windows and was completely destroyed, only the brick walls remaining. As the flames raced down First and Second Streets sparks carried ahead of the main fire ignited many wooden shingle roofs on one and two-family dwellings and outbuildings scattered through this section. The roaring mass of flames which constituted the main blaze soon closed the gaps.

The St. Louis Catholic Church, a large brick structure, and the St. Louis Convent, of fire-resistive construction, on Dunn Street between Second and Third Streets were not damaged, due primarily to the fact that they had noncombustible roof coverings and were protected on the exposed side by considerable open space and not in the direct path of the fire. Sparks and embers, however, soaring above, started fires farther on. The St. Louis parochial school on Dunn Street across Second was in the direct path of the fire and approximately 600 children were led to safety by the Sisters when the windows began to crack from the heat of the approaching fire. Half an hour after they had left, the building was only a brick shell.

A number of automobiles were burned, some in garages which were destroyed and others in the streets. In the latter instances the owners were unable to move them before the fast traveling fire reached them. As the fire

Ruins of St. Louis Parochial School at Second and Dunn Streets. When the heat cracked the windows in this apparently substantial brick structure, the four hundred children who were in their classrooms were led to safely by the Sisters.

rushed on, frenzied attempts were made by householders to save their furniture, bedding and clothing. Sidewalks were piled high with household effects, but in many cases all the efforts of their owners were of little avail. Before they could be moved farther a spark landed on them and they were burned where they lay. Electric light, telephone and fire alarm service throughout the New Auburn section was crippled by the fire. Charred poles and masses of burned wires littered the streets in the fire area.

At the height of the fire flying brands were carried across the river into Lewiston, starting several fires on wooden shingle roofs, one of which resulted in the destruction of a set of farm buildings. Grass and brush fires were also started on the Lewiston side of the river which, with the roof fires, kept the fire department on the jump during the afternoon and early evening.

About five o'clock, during a sudden gust of wind, a burning ember landed on the wooden shingle roof of the Wilson School, a two-story and attic frame structure at Fourth and Dunn Streets. This building was a full block away from the principal conflagration area and at the time of its ignition the main fire was virtually under control. Eyewitnesses state that the original blaze on the schoolhouse roof could have been readily extinguished by a pail of water, but no water was immediately available nor were there any means of reaching the roof. Eventually a ladder was obtained and a hose line stretched from a hydrant at the corner, only to find that the water pressure was insufficient to reach the seat of the fire, which spread rapidly over the old and dry

J. M. Morrison.

This school was more than a block away from the conflagration area at Auburn. Sparks set fire to its wooden shingle roof. The picture shows the roof furiously burning as a fire company attacked the fire. The fire spread rapidly over the combustible roof, gaining such great headway that the entire building was destroyed. This building was to have been re-roofed during the summer recess and the supply of fire retardant roofing for the purpose was in the basement at the time of the fire.

wooden shingles. A Portland pumper was dispatched to the scene and supplied the necessary pressure for the hose line, but by this time it was too late and the fire worked its way into the attic and thence downward through the entire building until nothing remained but the foundation walls. In the basement was a supply of fire-resistive roofing with which the structure was to have been re-roofed after the close of the school year in June.

At the extreme end of Second and Third Streets were four dwellings and a private garage. These structures were ignited by flying brands on wooden shingle roofs and it is thought that they could have been saved had there been water enough for even a garden hose, but none was available. A fire department pumper was sent to this area but lack of water prevented its use, and the buildings were razed.

Loss.

The property loss has been estimated at between $1,500,000 and $2,000,000, with an insurance loss reported estimated at from $900,000 to $1,000,000. As in previous conflagrations there were comparatively few partial losses and for the most part losses were either total or confined to a few roof shingles or scorched paint. The large number of persons rendered homeless may be accounted for by the fact that the dwellings were largely tenanted by

International.

The New Auburn fire sweeping down Third Street. Effective use of hose streams at Dunn and Third Streets stopped the progress of the fire southward beyond this point. Note hose streams which saved building in right center foreground.

mill hands and the number of persons to each house was high. There was no loss of life and but few minor injuries.

Fire Department Operations.

The Auburn fire department consists of 57 men, of whom 20 are full-paid permanent men and 37 are part-paid call men. The apparatus consists of one 750-gallon motor pumper, one city service ladder truck and two combination hose and chemical trucks stationed at the Central Fire Station; a 600-gallon motor pumper stationed on Goff Hill; and a 600-gallon motor pumper in New Auburn.

This force is adequate for ordinary conditions, but with the major portion of the department engaged at two other fires, the single pumper immediately available was insufficient to cope with a fire already assuming conflagration proportions when the fire department was summoned. The rest of the apparatus of the department arrived at the fire at intervals between 2:05 and 2.10 P.M., with the exception of the combination hose and chemical truck, which was engaged at a grass fire three miles from the Central Fire Station. This truck reached New Auburn at 2:25 P.M.

International.

The northern end of the conflagration area with the City of Lewiston in the background across the Androscoggin River. Three hose lines, stretched across the bridge from the Continental Mills, saved a tenement house near the bridgehead. Note closely built tenement district in Lewiston, which would have been severely threatened had wind direction changed.

The record of fire alarms received during the afternoon of the fire shows the disposition of the various fire companies at the start and indicates the rapidity of the spread of the conflagration.

1:30 P.M. Telephone call. Grass fire. Combination 1 responded.
1:45 P.M. Telephone call. Highland Avenue. Combination 2 responded.
1:48 P.M. Box 413 for fire on Highland Avenue. Engine 1, Engine 3 and Ladder 1 responded. Fire was on roof of ell of dwelling. Engine 2 responded from New Auburn to "cover-in" at Headquarters.
2:00 P.M. Box 211. Mill and Broad Streets. Start of conflagration. Engine 2 responded.
2:02 P.M. Box 211. Second alarm. Sounded on arrival of Engine 2 at the fire.
2:04 P.M. Call for additional aid from Lewiston. Sent out from Central Fire Station.
2:05 P.M. Call for aid from Lewiston. Sent out from fire area by fire alarm superintendent.
2:14 P.M. Box 213. First and Brook Streets.
2:15 P.M. Call for aid from Lewiston. Sent out from fire area.
2:20 P.M. Box 213. First and Brook Streets.
2:24 P.M. Box 213. First and Brook Streets.
2:40 P.M. Box 212. First and Dunn Streets.

International.

Ruins of the Auburn conflagration. At the left are the remains of the garage in which the fire had its origin, while in the center may be seen the cellar of the Shapiro Block, which occupied the triangle formed by Mill, Broad and Third Streets. See also picture on next page.

The response of the Lewiston fire department was prompt and one 750-gallon pumper, one 400-gallon pumper and a city service ladder truck were in service at the fire about as soon as the Auburn fire department. The distance from the Lewiston Central Fire Station to the fire is but three-quarters of a mile and one pumper is even nearer. The Lewiston apparatus was stationed at various places, the rapid spread of the fire making it necessary to change positions frequently. Six hose streams were used from Lewiston pumpers and, in addition, three hose streams were stretched across the bridge from the 1000-gallon Underwriters' fire pump of the Continental Mills in Lewiston to a point beyond Broad and First Streets. The pump operated at 150 pounds pressure and the streams were effective in saving a wooden tenement at the New Auburn end of the bridge in the fire area. The Lewiston as well as the Auburn fire department lost considerable hose in the fire, and five trips were made by Lewiston apparatus with additional hose and supplies.

The Lewiston fire department was kept busy during the period of the fire, as is evidenced by the following record of alarms received by the Lewiston fire alarm office.

2:00 P.M. Engine 1 and Ladder 1 to Auburn.
2:10 P.M. Engine 5 to Auburn.

International.

This picture is a continuation of that shown on the opposite page. The ruins of Olum's Store (see photo on page 64) are in the foreground. In the background are frame structures on Third Street, some of which were damaged but saved from total destruction by the efforts of the Auburn firemen.

2:45 P.M. Box 63. Park and Maple Streets for room fire in apartment block.
2:50 P.M. Chief's call followed by box 37 to summon call men for Auburn fire.
2:59 P.M. Box 79. Lisbon and Dale Streets for roof fire at 94 Prospect Street, caused by brand from Auburn fire.
3:44 P.M. Box 79. Lisbon and Dale Streets for fire in group of farm buildings on South Avenue caused by brands from Auburn fire.
4:13 P.M. Box 79. Lisbon and Dale Streets for roof fire on Rosedale Street, caused by brand from Auburn fire.
4:33 P.M. Engine 2 sent to Auburn with hose.
5:20 P.M. Engine 1 sent to Auburn.
6:00 P.M. Engine 2 sent to fire on South Avenue.
9:25 P.M. Woods fire on Pleasant Street caused by flying brands from Auburn fire.
9:55 P.M. Chief's call followed by box 37 for woods fire, Pleasant Street.

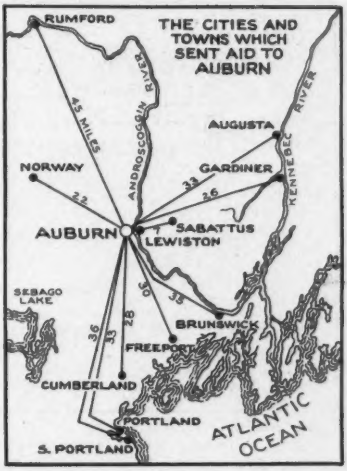
The first request for outside aid, other than Lewiston, was made at about 2:20 P.M., and within a short time calls for help were sent out to ten cities and towns from 10 to 45 miles away. Eleven pumpers and other apparatus, together with firemen, answered the calls, the first arriving shortly before three o'clock and most of the others at various intervals during the next three hours. The ability of such outside aid to assemble quickly was an important factor in the emergency. Some of the pumpers worked at the fire for varying

Acme Photo.

Airplane view of the section of New Auburn devastated by the conflagration of May 15, 1933. Note complete destruction of all buildings within the burned area. The fire started in the triangular block at the top center of the picture and spread southward along the river. Note ruins of school at extreme left of picture, which burned when stray sparks ignited wooden shingle roof. (See also diagram on page 60.)

periods of from four to fourteen hours, while others covered in at vacated fire stations in Auburn and Lewiston.

Because of the heat generated during the early stages of the fire it was almost impossible to work in advance of the fire or to check its forward progress, and the efforts of the firemen were largely confined to holding it within narrow limits. Some of the pumpers were unable to obtain a good suction supply from hydrants, while others, after trying various locations, furnished good streams which were used effectively in preventing the spread of the fire laterally. Two pumpers drafted from the Little Androscoggin River, providing satisfactory hose streams from this source.



The accompanying table shows the cities and towns which rendered aid, the distances traveled, time of run and approximate time of operation.

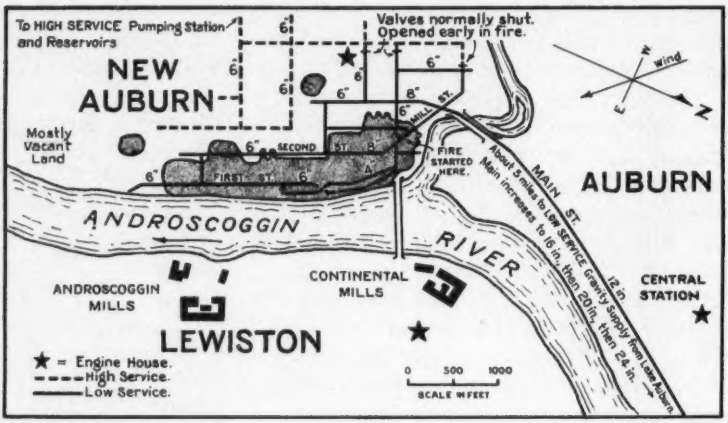
During the absence of the Portland companies their stations were covered by a company from South Windham with a 350-gallon pumper and twelve men, and sixteen men of the American Legion fire emergency unit, who manned two reserve hose trucks. Other cities and towns had no apparatus covering vacant stations while the companies sent to Auburn were absent.

Outside Help Sent to Auburn.

City or Town	Approximate Time of Arrival	Motor Pumpers	Men	Number of Streams Used	Miles	Approximate Time Run	Operation
Augusta	3:28 P.M.	1	12	2	33	43 min.	7 hours
Brunswick	No data	1	No data		35	No report	
Cumberland.	No data	x	No data	*	33	No report	
Freeport	8:00 P.M.	1	14	*	30	1 hr. 50 min.	—
Gardner	5:55 P.M.	1	10	**	26	55 min.	—
Lewiston	2:15 P.M.	2	25	6	¾	3 min.	10½ hours
Norway	3:20 P.M.	1	14	2	22	23 min.	14 hours
Portland	3:15 P.M.	2	12	3	33	45 min.	4 hrs. 10 m.
							9 hours
Portland	5:20 P.M.	1	5	**	33	45 min.	—
Rumford	5:16 P.M.	1	10	**	45	1 hr. 6 min.	—
Sabattus	2:55 P.M.	1	—	2	7	8 min.	8 hours
South Portland...	5:35 P.M.	1	5	Booster	36	55 min.	—

xCumberland sent a combination hose and chemical truck.
Lewiston also sent a ladder truck.
*Covered-in at Auburn stations.
**Covered-in at Lewiston stations.

Detours and heavy traffic account for the long time for Freeport to make the 30-mile run.



Factory Mutual Record.

The Auburn fire area, showing details of water supply mains and location of nearest fire stations in Auburn and Lewiston. When the fire broke out, the New Auburn pumper was "covering in" at the Central Station in Auburn proper.

Auburn and all of the communities that sent apparatus have standard hose coupling threads. The out-of-town equipment could therefore be connected with Auburn hydrants and there was no appreciable delay in making effective use of outside aid. Some slight difficulty was experienced due to lack of uniformity of suction hose sizes and suction hose threads, particularly when an attempt was made to piece out the suction lines of pumpers drafting from the river.

Water Supply.

The public water supply is a gravity system of water works owned by the city. The water mains are on two services, a low service supplied by gravity from Lake Auburn and a high service from a 7,500,000-gallon reservoir on Goff Hill.

The pumping equipment which delivers the water from Lake Auburn to the mains and reservoir consists of a 2,600,000-gallon per day electrically driven centrifugal pump (also equipped with an auxiliary gasoline engine drive) and a 1,400,000-gallon per day electrically driven centrifugal pump. The high service station on Court Street, normally held in reserve, has two electrically driven centrifugal pumps of 1,400,000 gallons per day capacity. The high and low service systems are interconnected with valves normally kept shut.

The fire area is normally served by the low service, primarily through 6-inch mains (an 8-inch main ran through Mill Street and part of Second Street) fed by a single long 12-inch main. The upper part of New Auburn is

International.

Another view of the Wilson School at Cook and Fourth Streets after fire starting on its wooden shingle roof had practically razed it. Lack of apparatus at the start of this fire and inadequate water supply were factors in permitting this fire to get beyond control. This building was more than a block outside of the main conflagration area.

served by the high service, consisting of an 8-inch feed main supplying 6-inch mains in the streets adjoining the fire. Gates between the high and low service were provided at several points, and these were opened at 2:04 P.M. shortly after the start of the fire. The hydrant spacing was poor and the number of dead end hydrants in the fire area somewhat handicapped the fire department.

At the beginning of the fire the pump at the Lake Auburn station was operating, delivering 1100 gallons per minute into the system, and at about 2:25 P.M. the 1000-gallon per minute pump at the high service station was started. Both continued for a period of 16 hours. At the end of that time the reservoir level was down about 2½ feet from full, but only 8 inches lower than at the same time the previous day. It is estimated that approximately 2,500,000 gallons of water were used for fire fighting, about 800,000 gallons of which were drawn from the reservoir, the remainder being supplied by the pumps.

Previous tests made near the point where the fire started indicated that the total amount of water available in the section was approximately 2000 gallons per minute, but due to the small size mains considerably lesser amounts were available toward the southern extremity of the fire area. Statements of fire department members as to the number of streams which were in use at times would indicate that the water system was severely overtaxed and

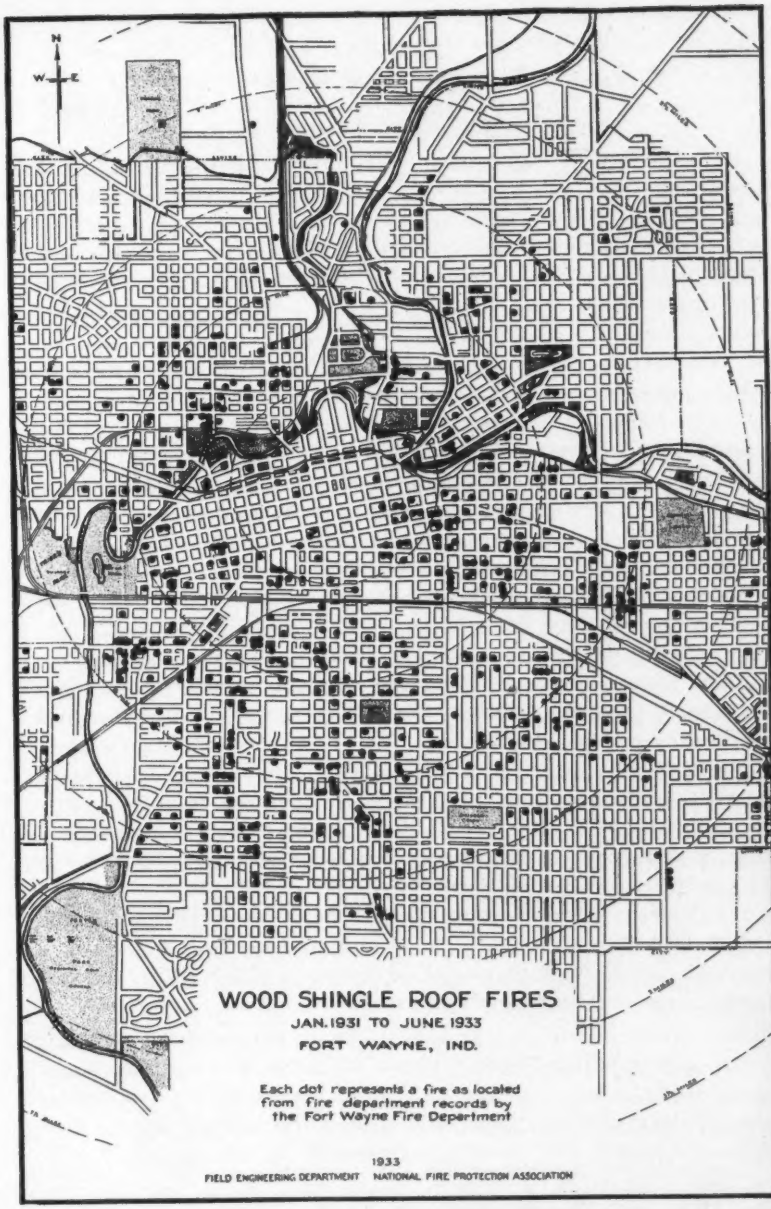
none of the streams particularly effective. At the height of the fire seven pumpers were drawing water from the water system, and two were taking suction from the river. It is estimated that the former furnished a maximum of 18 streams at one time, while four were supplied by the latter and three by the fire pump at the Continental Mill.

During the progress of the fire three hydrants were abandoned, and the system was further bled by broken piping in buildings. An attempt was made to conserve the water supply by shutting off sections of mains supplying abandoned hydrants, later opening these sections when it was possible to close the hydrants themselves. Other sections of water mains were closed during the progress of the fire to reduce waste and to furnish supply to pumpers which at times found difficulty in obtaining water.

Observations made by an insurance engineer at 6:00 P.M., when most of the buildings had been consumed, indicated that the various pumping engines attached to hydrants on Third and Fourth Streets were unable to obtain very much water. At about 6:30 P.M. a visit was made to a sprinklered plant located at the extreme end of the water main on First Street, where gauges on the sprinkler riser registered zero pressure. An attempt by a fire department pumper to connect to a hydrant on First Street at 7:00 P.M. was witnessed and no water was obtainable. It is stated by the water department that gates were opened to all sections about 6 P.M. Any loss of pressure subsequent to that time was due to the open services.

Pressures observed on the suction side of several pumping engines at about 1:00 A.M., May 16th, were practically zero, with the exception of two pumpers at higher elevations, where the pressures on the suction side of the pump were from 35 to 40 pounds. These conditions, observed after the fire was under control, indicated that pumpers on higher levels were obtaining water at reasonably good pressure, while those on lower levels were considerably restricted in supply. This may be accounted for by the fact that valves had been operated on the system, reducing flow of water into the lower levels but retaining it on the higher elevations. This seems to indicate clearly that some pumpers may have obtained a fair supply of water at the expense of other pumpers.

Note:—The foregoing reports on the Ellsworth and Auburn conflagrations have been prepared by Mr. H. S. Walker, Field Engineer N.F.P.A., who was present during or immemediately following the conflagrations. Acknowledgment is made to Mr. P. C. Charnock and Mr. Walter H. Merchant, Jr., of the New England Insurance Exchange (Member N.F.P.A.), for their coöperation and assistance.—Ed.


N
W
E
WOOD SHINGLE ROOF FIRES
JAN. 1931 TO JUNE 1933
FORT WAYNE, IND.
Each dot represents a fire as located from fire department records by the Fort Wayne Fire Department
1933
FIELD ENGINEERING DEPARTMENT NATIONAL FIRE PROTECTION ASSOCIATION

Atlantic Pyroxylin Waste Co. Fire,

North Arlington, N. J., June 9, 1933.

Ten persons lost their lives and approximately one hundred others were burned when fire wrecked the plant of the Atlantic Pyroxylin Waste Company at North Arlington, N. J., shortly after 9:12 P.M. on June 9, 1933. The initial flames were followed by a "puff" or "blast" of fire, due to the ignition of accumulated combustible gases which forced out both ends of the building. The factory building was completely gutted and adjacent buildings were severely damaged.

The Atlantic Pyroxylin Waste Company bought pyroxylin scrap from various manufacturing plants, and girls sorted it and graded it for resale to pyroxylin manufacturers and lacquer plants. The scrap was received and stored in wooden boxes and barrels. These containers were piled indiscriminately and in part of the building as high as the eave lines. The plant was congested and aisle spaces were inadequate. It has been estimated that there was about 15 tons of scrap in the building at the time of the fire.

The main plant consisted of a one-story concrete block, single area building, 80 ft. x 50 ft., with a small boiler room cut off by fire-resistive partitions. The building had a low peaked joisted roof on wood timber trusses with a clear span between the side walls. There were no skylights or ventilators.

The building was equipped with an automatic sprinkler system with 64 heads in the room where the fire started. There was some obstruction to distribution due to high piled boxes and barrels. An alarm valve was connected to local bells. The water supply to sprinklers was through a 6-inch connection from a 6-inch street main with a static pressure available of 90 lbs.

On the west side (river side) of River Road was a one-story frame shed, 20 ft. x 20 ft., used for the storage of pyroxylin shavings and excess scrap. This building was not sprinklered.

This fire is primarily chargeable to an excessive amount of pyroxylin scrap in the building, stored in violation of the recognized safe methods recommended by the N.F.P.A. Committee on Hazardous Chemicals and Explosives for the storage and handling of this material.

Story of the Fire.

Operations in the plant had stopped for the day at 5 P.M. and no one is known to have been in the plant subsequent to that time. The day had been extremely hot with the thermometer around 100° F. and high humidity.

This report has been prepared from data furnished by the Eastern Underwriters Inspection Bureau (Member N.F.P.A.), the Schedule Rating Office of New Jersey (Member N.F.P.A.), and N.F.P.A. engineers.

Acme Photo.

The plant of the Atlantic Pyroxylin Waste Company at North Arlington, N. J., showing damage which resulted when accumulated gases from burning pyroxylin waste forced out both ends of the building.

Along the river near the plant are small bathing beaches which were well populated on this day by local people seeking relief from the heat.

The fire was discovered at about 9:12 P.M., when flames were noticed shooting up through the roof. There were no vents in the roof, and the fire apparently burned for a short time until the accumulated gases built up sufficient pressure to force out both ends of the building. This "puff" or "blast" of flames and gases set fire to several exposures and resulted in loss of life to seven persons in near-by or adjacent dwellings. The burning pyroxylin gave out intense heat within a radius of approximately 350 feet, and nine buildings, including a gas station, several garages and a number of dwellings, were more or less damaged. Two of the dwellings were very nearly a total loss.

All of the sprinklers in the building opened, and while they could not have been expected to control a fire in such a large quantity of exposed and improperly stored pyroxylin material, it is apparent that they must have helped considerably. This is evidenced by the fact that some of the pyroxylin material was not consumed and many of the wooden containers were hardly scorched. The sprinklers continued to operate until the fire was extinguished and were a material factor in preventing further loss after the pyroxylin material had burned out.

The original blast of flames from the main building was quickly followed by another from the small storage building across River Road adjacent to the beach. It was this second "puff," with its accompanying cloud of hot gases, that endangered the bathers and precipitated a panic. The intense heat forced swimmers and non-swimmers alike into deep water, and the fact that only two were drowned reflects credit to those who assisted in the many rescues.

Of the ten persons who were burned to death, seven were in, or adjacent to, near-by dwellings and the remainder on the river front. It is fortunate that the burst of flame occurred at a time when travel on River Road was relatively light. Otherwise the loss of life might have been more severe. There

International.

Airplane view of plant of Atlantic Pyroxylin Waste Company at North Arlington, N. J., where fire cost the lives of ten persons and injured approximately 100 others. The plant where the fire started may be seen in the upper center of the picture. Adjoining the plant is the Appleyard dwelling, where five persons lost their lives. Across the street is dwelling where two persons were burned to death as they sat on piazza. In the background is the river front where other deaths and injuries occurred. The presence of garage building between the fire and the beach was a factor in preventing more serious loss of life.

were a considerable number of people on the bathing beach and it was here that most of the injuries occurred. But for the metal building between the beach and the pyroxylin waste plant the loss of life would doubtless have been more severe. As it was, there were thirty or more people very seriously burned, and the total number who applied for major treatment was 83. Many others received minor burns.

When the fire started, the mother and father of the Appleyard family in the residence adjoining the plant were in the house. In the back yard was their married daughter with two children. When the first flash occurred those outside ran for safety, but the daughter almost immediately ran back into the house in an attempt to save her 2½-year-old baby. The intense heat and flames enveloped the house and those within had no opportunity to escape. The mother, father, married daughter and baby were trapped and

A. P. Photo.

Ruins of the Appleyard dwelling adjoining the plant of the Atlantic Pyroxylin Waste Company plant at North Arlington, N. J. Four persons were trapped in this building by the intense heat and flames and burned to death. A child in the back yard was so seriously burned that it later died.

died. A child who was in the back yard was so badly burned that it died later. In a dwelling across Hawthorne Avenue two women, who were on the front porch at the time of the fire, were burned to death and a man was severely burned. On the beach one woman is known to have been fatally burned, and two other persons were drowned.

At the time of writing this report the exact cause of the fire has not been determined. There seem to be two possible causes—incendiarism or spontaneous ignition. In regard to incendiarism, there had been rumors that competition was rather keen between this firm and others and that threats had been made to stop the business. An investigation of this possible cause is being made by the police.

In considering spontaneous ignition as a possible cause it should be borne in mind that the scrap material must have been well seasoned, as it had been worked in some other mill before it became scrap. There was, however, one unusual feature. For two days the heat had been intense and temperature was around 100° F., indicating a possibility that decomposition might have started in some of the scrap, which had been swept up from floors and may have contained oily waste or other material which might have heated up and started the fire.

The property loss from the fire was estimated to be in the vicinity of from $50,000 to $60,000, of which from $10,000 to $15,000 was on the plant of the Atlantic Pyroxylin Waste Co. The remainder of the loss was on exposures.

San Francisco Chronicle.

The Key System Pier, Oakland, Cal., looking east, after the fire of May 6, 1933. No. 1 Slip, where the ferry Peralta was burned, is in the foreground. The fire started near the point where the fireboat is tied up in Slip No. 2. Wind from the south (right) rapidly spread fire across the pier.

Oakland, California, Pier Fire.

On Saturday, May 6, 1933, shortly before 10 P.M. and during a heavy wind and rain storm, a fire started near the center of the three loading slips of the Key System, Limited, at Oakland, California. Due to the open construction of the terminals, the strong wind and the inability of the fire departments to promptly reach the scene, the fire spread very rapidly and was soon beyond the control of local protection. The loss on the pier structure was $203,000, to a ferry boat docked at the terminal $800,000, and to trains and miscellaneous equipment possibly $140,000 more. The amount of the use and occupancy loss has not been determined.

Local protection consisted of a combination electric and gasoline driven pump supplying salt water through a 4-inch main to numerous 2½-inch outlets. An adequate supply of hose, well located, was available. As a result of tests made some time ago by the engineering department of the Board of Fire Underwriters of the Pacific, it was stated that this local water system was inadequate in view of the large amount of frame construction.

The Key System lines transport passengers across San Francisco Bay between East Bay cities and San Francisco. Their trains carry passengers from various points in the East Bay out to the ferry terminals situated at the end of a trestle and wharf approximately two miles from a filled-in grading which extends about four miles out from the Oakland shore line.

The trestle leading to the terminal is protected by a 5-inch fresh water main which extends its entire length and feeds numerous 1½-inch outlets. First aid equipment was provided by 2½-gallon soda-acid extinguishers, 40-gallon soda-acid extinguishers on wheels, buckets of water and large boxes of sand in the vicinity of the oil tanks. There were five monitors located at strategic points. Two watchmen with approved clocks and carrying small extinguishers were on duty every night. The fire alarm system consisted of eight boxes with a gong at each. Flat cars were located at the land end of the pier to transport fire equipment to the terminal in case of need. Fire drills were held regularly and signs posted instructing employees what to do in case of fire.

The Key System terminal at the westerly end of the trestles and wharf was an old structure built in 1903, consisting of approximately 75,000 square feet of sheds, offices, waiting rooms, lavatories, etc., of light frame construction, one and two stories high, largely with open sides. The wharf was constructed of heavy wood planks on 4 x 12 in. wood joists on 10 x 12 in. wood

This report has been prepared from data furnished by the Board of Fire Underwriters of the Pacific (Member N.F.P.A.), and Mr. S. D. McComb, Chairman, N.F.P.A. Marine Committee.

San Francisco Chronicle.

Oakland Pier fire at its height, showing burning pier deck and cars.

beams. The whole structure was open underneath and built on wooden and concrete piles. Open ramps led to upper portions for loading and unloading passengers on upper decks of boats.

Story of the Fire.

One of the watchmen, while making his rounds, was probably the one who saw the fire first. He ran to the nearest fire alarm box and turned in an alarm. The Key System general offices were informed of the fire by telephone at 10:04 P.M., and in turn immediately telephoned the Oakland and San Francisco fire departments.

The last ferry boat to leave the pier prior to the fire had departed from Slip No. 2 at 9:40 P.M., the ferry boat *Peralta* was in Slip No. 1, the *San Leandro* was in Slip No. 3, and another ferry was at the mooring place just beyond the slips. The fire apparently started below the apron at the northeast corner of Slip No. 2. From this point the flames spread rapidly inward and thence up through the office buildings and straight across the tracks of the terminal.

As soon as the alarm sounded, Key System employees started the fire pump and brought into use several hose streams and chemicals. A 35-mile per hour wind was blowing from the south and fanned the fire so that the entire upper structure was afire, the roof and power lines were falling, and the fire pump was helpless due to breaking pipes within ten to fifteen minutes. Some of the trains were taken out of danger before the power went off. Witnesses state that the fire had spread to Slip No. 1 within five minutes, and from here it communicated to the *Peralta*.

Although three men went aboard the *Peralta,* it appears that but little effort was made to save the ship. While they released the lines holding the ferry on the west side as they went aboard, no attempt was made to get off the double lines on the east side nearest the fire, although axes were readily available. Had all the lines on the *Peralta* been cut, she could have been towed out and away from the burning pier. Meanwhile the crew of the *San Leandro* left the ship to assist in fighting the fire on the slip. When the water supply gave out they returned to the ferry, which pulled out at about 10:20 P.M. The *San Leandro* was equipped with a monitor nozzle, but it was not used.

The *Peralta,* which originally cost over $1,000,000, was of the turbo-electric type, all-steel construction with the exception of teakwood cabins on the upper deck, wood seats and trim. Practically all of the superstructure was destroyed; the generators, motors, etc., were badly damaged by fire and by the large amount of salt water thrown on them. The steel hull was also badly damaged.

About thirty sailors from Yerba Buena Island were the first outsiders to arrive and were a great aid in fighting the fire. The fireboat *Dennis Sullivan* arrived soon after from San Francisco, approximately three miles distant. The Oakland fire department, being without a fireboat, had to depend on apparatus transported to the fire on flat cars over the Key System tracks and trestle. The electric power went off at 10:08 P.M. and left two Oakland pumpers stranded on the trestle about two miles from the fire for over an hour.

There were eight fuel oil tanks of 10,000-gallon capacity each on the wharf between Slips Nos. 2 and 3, just south of where the fire was started. The fireboat *Dennis Sullivan* kept these well covered with water and prevented them from burning.

When the Oakland fire department arrived at the fire they did excellent work in coöperation with the other fire fighters in confining the fire to the section which was already doomed. There was no loss of life nor serious casualty, all passenger trains having departed before the fire started. The entire 75,000 square feet of upper structure, approximately 120,000 square feet of wharf and substructure, at least 14 steel cars and the ferry boat *Peralta* were totally destroyed, with the exception of a little salvage on the ferry boat. The fact that the wind was blowing at right angles to the length of the trestle and wharf, and the ease with which the fire fighters could tear up the wood planking to fight the fire from the underside, were factors in keeping the loss from one of a far greater magnitude.

Fires in Which There Was Loss of Life.

Since the publication of the April QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 152 reports of fires in which there has been loss of life. A total of 243 lives were lost in these fires. The following tables do not include five fires occurring outside of the United States and Canada, in which a loss of 18 lives is reported.

There were three disasters in which large loss of life occurred during the period covered by this record. The first of these was the explosion at an oil refinery at Long Beach, Calif., on June 2. Ten lives were lost as a result of this explosion. The second disaster occurred on June 9, when an explosion occurred in a pyroxylin waste plant at North Arlington, N. J., causing the deaths of ten persons who were in the vicinity. This fire is reported on page 80 of the QUARTERLY. The third major accident occurred at Glen View, Ill., on June 11, when a sightseeing airplane from the Century of Progress Exhibition crashed and burned, resulting in the death of nine occupants.

Loss of Life Fires, April-June, 1933.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Lives Lost. Men	Women	Children	No Data	Total
Airplane fires	7	18	2	0	0	20
Apartments, hotels, lodgings, tenements, etc.	12	4	5	10	0	19
Automobile fires	9	12	1	0	0	13
Barns and stables	1	1	0	0	0	1
Churches	1	1	0	0	0	1
Dwellings—Rural	55	26	26	28	6	86
Dwellings—Urban	35	9	19	14	0	42
Garages	1	2	0	0	0	2
Industrial occupancies	4	6	4	2	1	13
Institutions, schools, etc.	3	2	2	0	0	4
Mining property	2	5	0	0	0	5
Oil fields	1	1	0	0	0	1
Oil refineries	3	11	1	1	0	13
Other buildings	4	5	1	2	0	8
Outside of buildings	11	7	0	4	0	11
Powder plants	1	2	0	0	0	2
Response to alarms	2	2	0	0	0	2
Total	152	114	61	61	7	243

*This table is made up from those reports received by the Department of Fire Record between April 1 and June 30, 1933. A few of the fires included herein occurred prior to April 1, but were not reported until subsequent to that date.

Causes of Loss of Life, April-June, 1933.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Cause	Men	Women	Children	No Data	Total
Airplane fires	18	2	0	0	20
Automobile fires	12	1	0	0	13
Baby fell in fire	0	0	1	0	1
Children alone in house	0	0	1	0	1
Children and matches	0	0	4	0	4
Cleaning with gasoline	2	3	0	0	5
Clothing ignited:					
Bonfire, campfire, rubbish	1	0	0	0	1
Fireplace	1	2	1	0	4
Furnace or stoves	1	9	2	0	12
Gas heater	1	1	1	0	3
Gun powder	1	0	0	0	1
Matches	0	2	0	0	2
Spark from incinerator	0	0	1	0	1
Escaping from fire—jumped or fell	0	0	1	0	1
Explosion or flash fire:					
Alcohol torch	0	0	1	0	1
Carbide	2	0	0	0	2
Coal pulverizer	1	0	0	0	1
Gasoline stove	1	1	0	6	8
Illicit still	2	1	0	0	3
Illuminating gas	0	2	0	0	2
Incubator	0	2	0	0	2
Kerosene oil stove or lamp	0	2	0	0	2
Mine	5	0	0	0	5
Munition plant	2	0	0	0	2
Oil field	1	0	0	0	1
Oil on stove	0	0	1	0	1
Oil refinery	11	1	1	0	13
Pyroxylin	4	4	2	1	11
Fire fighting	3	0	0	0	3
Forest or brush fire	0	0	2	0	2
Gasoline used to start fire	1	2	2	0	5
Ignition of flammable liquids or vapors	5	3	0	0	8
Kerosene used to start fire	3	7	11	0	21
Overcome by smoke—suffocation	2	1	4	0	7
Overexertion or excitement	2	2	0	0	4
Re-entering burning buildings	2	3	1	0	6
Response to alarms	2	0	0	0	2
Smoking	4	1	0	0	5
Tank truck accidents	1	0	1	0	2
Trapped in burning building	22	8	20	0	50
Trapped in burning building by prairie fire	0	1	2	0	3
Unknown	1	0	1	0	2
Total	114	61	61	7	243

Typical Loss of Life Fires.

Children and Matches.

L-2026. CHELSEA, MASS., MAY 9, 1933. A nineteen-month-old baby was burned to death in his crib by a fire which started when his brother one year older played with matches. The fire occurred in the morning before the parents were awake. Burned matches told the story.

Cleaning with Gasoline.

L-2027. WATERVILLE, ME., MAY 20, 1933. An elderly woman died of burns as the result of an explosion of gasoline with which she was cleaning a dress. She ran from her house with her clothing aflame and a neighbor extinguished the flames by rolling her on the ground, but not before she had been fatally burned.

Ignition of Flammable Liquids or Vapors.

L-2029. ALMA, MICH., APRIL 25, 1933. After escaping unhurt from an automobile crash in which a companion was killed, a man was fatally burned when his gasoline saturated clothing ignited as he lighted a cigarette.

L-2030. MONTREAL, P. Q., MAY 4, 1933. A woman was using a mixture of benzine and Paris green to clean vermin from a mattress and bedstead. She lighted a match to see if she could locate any vermin and dropped the match into the pan containing the mixture, which ignited and set fire to her clothing.

L-2031. RIDGEFIELD PARK, N. J., MAY 20, 1933. A young man died of burns received when gasoline was poured over automobile motor to make it start, following a rainstorm. When his brother pressed the starter the gasoline exploded and ignited the clothing of the victim.

Illuminating Gas Explosion.

L-2033. MIDDLEBOURNE, W. VA., APRIL 24, 1933. Two women were killed, another was critically injured, and two young men who attempted to save their mother were burned as the result of an illuminating gas explosion which wrecked a dwelling. The explosion occurred when one of the women struck a match while investigating the odor of escaping gas. The resulting explosion wrecked the building and set it on fire. One of the victims was killed outright and the other died in a hospital.

Kerosene Used to Start Fire.

L-2035. RAPID CITY, S. D., MAY 8, 1933. Six members of a family were burned to death in a fire which started when the father used kerosene to kindle a fire in the kitchen stove. Both parents and four children were burned to death. Three other children escaped from the two-room dwelling.

L-2036. ROCKFORD, MICH., MAY 15, 1933. A woman was burned to death as a result of using kerosene to start her kitchen fire. She did not realize that any live coals remained, and when she poured the kerosene it flashed up and ignited her clothing. Two sons received burns in aiding their mother.